PROCEEDINGS

OF THE

BOARD OF AGRICULTURE IN INDIA

HELD AT

COIMBATORE

ON THE

8th December 1913, and following days

WITH APPENDICES

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1914

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FROM

THE HON'BLE MR. J. MACKENNA, M.A., I.C.S.,
Offg. Agricultural Adviser to the Government of India and Director, Agricultural Research Institute, Pusa.

To

THE SECRETARY TO THE GOVERNMENT OF INDIA,
DEPARTMENT OF REVENUE AND AGRICULTURE,
SIMLA.

PUSA, *the 13th January, 1914.*

SIR,

I have the honour to submit the Proceedings of the 8th Meeting of the Board of Agriculture in India, held at Coimbatore, Madras Presidency, on the 8th December, 1913, and following days. These Proceedings have been recorded by Mr. A. C. Dobbs, Assistant to the Agricultural Adviser to the Government of India, who acted as Secretary. The Proceedings have been approved by the Board.

I have the honour to be,

SIR,

Your most obedient Servant,

J. MACKENNA,

Offg. Agricultural Adviser to the Government of India and Director, Agricultural Research Institute, Pusa.

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The Eighth Meeting of the Board of Agriculture in India.

INTRODUCTORY.

1. THE Eighth Meeting of the Board of Agriculture was held at Coimbatore, Madras Presidency, *on the 8th December, 1913, and following days under the* presidency of Mr. J. Mackenna, M.A., I.C.S., Officiating Agricultural Adviser to the Government of India and Director, Agricultural Research Institute, Pusa.

MEMBERS.

The members present were :—

1. J. Mackenna, M.A., I.C.S., Officiating Agricultural Adviser to the Government of India and Director, Agricultural Research Institute, Pusa (President).
2. A. C. Dobbs, B.A., Assistant to the Agricultural Adviser to the Government of India, Pusa (Secretary).
3. J. W. Leather, V.D., PH.D., F.I.C., Imperial Agricultural Chemist, Pusa.
4. E. J. Butler, M.B., F.L.S., Imperial Mycologist, Pusa.
5. S. Milligan, M.A., B.Sc., Imperial Agriculturist, Pusa.
6. T. Bainbrigge Fletcher, R.N., F.E.S., F.Z.S., Imperial Entomologist, Pusa.
7. Major J. D. E. Holmes, M.A., D.Sc., M.R.C.V.S., Imperial Bacteriologist, Muktesar.
8. D. Hooper, F.C.S., F.L.S., Economic Botanist to the Botanical Survey of India, Calcutta.
9. J. R. Blackwood, M.A., I.C.S., Director of Agriculture, Bengal, Calcutta.
10. G. P. Hector, M.A., B.Sc., Economic Botanist, Bengal, Dacca.
11. Major A. Smith, F.R.C.V.S., Principal, Veterinary College, Belgachia (Calcutta).
12. W. B. Heycock, B.A., I.C.S., Director of Agriculture, Bihar and Orissa, Ranchi.
13. E. J. Woodhouse, M.A., F.L.S., Economic Botanist and Principal, Agricultural College, Sabour, Bihar and Orissa.
14. G. C. Sherrard, B.A., Deputy Director of Agriculture, Bihar and Orissa, Bankipur.
15. D. Quinlan, I.C.V.D., Superintendent, Civil Veterinary Department, Bihar and Orissa, Ranchi.
16. The Hon'ble Mr. H. R. C. Hailey, I.C.S., Director of Land Records and Agriculture, United Provinces, Lucknow.
17. A. E. Parr, M.A., B.Sc., PH.D., M.S., Deputy Director of Agriculture, United Provinces, Western Circle, Aligarh.
18. G. Clarke, F.I.C., Agricultural Chemist, United Provinces, Cawnpore.
19. E. W. Oliver, M.R.C.V.S., F.Z.S., Superintendent, Civil Veterinary Department, United Provinces, Lucknow.
20. W. S. Hamilton, B.A., I.C.S., Director of Agriculture and Industries, Punjab, Lahore.
21. J. H. Barnes, B.Sc., F.I.C., F.C.S., A.R.I.P.H., Agricultural Chemist and Principal, Agricultural College, Lyallpur, Punjab.
22. W. Roberts, B.Sc., Professor of Agriculture, Agricultural College, Lyallpur, Punjab.
23. Col. H. T. Pease, M.R.C.V.S., C.I.E., Principal, Veterinary College, Lahore, Punjab.

24. Lt.-Col. J. Farmer, F.R.C.V.S., Chief Superintendent, Civil Veterinary Department, Punjab, Lahore.
25. W. W. Smart, I.C.S., Director of Agriculture, Bombay, Poona.
26. Harold H. Mann, D.Sc., Agricultural Chemist and Principal, Agricultural College, Poona.
27. W. Burns, B.Sc., Economic Botanist, Bombay, Poona.
28. Lt.-Col. H. M. Maxwell, F.R.C.V.S., Superintendent, Civil Veterinary Department, Bombay, Poona.
29. D. T. Chadwick, I.C.S., Director of Agriculture, Madras.
30. C. A. Barber, M.A., Sc.D., F.L.S., Government Sugarcane Expert, Coimbatore.
31. R. W. B. C. Wood, B.A., Principal, Agricultural College, Coimbatore.
32. H. C. Sampson, B.Sc., F.H.A.S., F.B.S.E., Deputy Director of Agriculture, Madras, Southern Circle, Trichinopoly.
33. W. H. Harrison, M.Sc., Government Agricultural Chemist, Coimbatore.
34. F. Ware, M.R.C.V.S., Superintendent, Civil Veterinary Department, Madras.
35. R. G. Allan, M.A., Principal, Agricultural College, Nagpur.
36. D. Clouston, M.A., B.Sc., Deputy Director of Agriculture, Central Provinces, Nagpur.
37. G. Evans, M.A., Deputy Director of Agriculture, Central Provinces, Northern Circle, Jubbulpore.
38. H. Clayton, M.A., I.C.S., Director of Agriculture, Burma, Mandalay.
39. Col. G. H. Evans, C.I.E., F.L.S., M.R.C.V.S., I.C.V.D., Superintendent, Civil Veterinary Department, Burma, Rangoon.
40. J. McSwiney, M.A., I.C.S., Director of Land Records and Agriculture, Assam, Shillong.
41. A. G. Birt, B.Sc., Deputy Director of Agriculture, Assam, Shillong.
42. A. A. Meggitt, B.Sc., F.C.S., Agricultural Chemist, Assam, Shillong.
43. W. Harris, M.R.C.V.S., Superintendent, Civil Veterinary Department, Assam, Shillong.
44. W. Robertson Brown, Agricultural Officer, North-West Frontier Province, Peshawar.
45. Ram Gopal, M.A., M.R.A.C., P.A.S.I., N.D.D., Director of Agriculture, Kashmir, Shrinagar.
46. M. A. Sitole, B.A., M.R.A.C., Bar.-at-Law, Director of Agriculture and Industries, Baroda.
47. L. C. Coleman, M.A., Ph.D., Director of Agriculture, Mysore, Bangalore.
48. N. Kunjan Pillai, M.A., B.Sc., Ph.D., Director of Agriculture, Travancore, Trivandrum.
49. R. D. Anstead, B.A., Planting Expert, United Planters' Association of Southern India, Bangalore.

Visitors.

2. In addition, the following attended as visitors :—

1. The Hon'ble Sir Robert Carlyle, K.C.S.I., C.I.E., I.C.S., Member, Revenue and Agriculture Department, Government of India.
2. The Hon'ble Sir John Atkinson, K.C.S.I., Senior Member of Council, Government of Madras.
3. The Hon'ble Mr. L. M. Wynch, C.I.E., I.C.S., Member, Board of Revenue, Madras.
4. The Hon'ble Mr. R. C. C. Carr, I.C.S., Member of the Board of Revenue, Madras.
5. The Hon'ble Sir Alfred G. Bourne, K.C.I.E., D.Sc., F.R.S., Director of Public Instruction, Madras.

6. Arno Schmidt, Secretary, International Federation of Master Cotton Spinners' and Manufacturers' Associations.
7. The Hon'ble Dewan Bahadur L. D. Swamikannu Pillai, M.A., B.L., LL.B., Registrar of Co-operative Societies, Madras.
8. Col. F. W. Hallowes, Director of Dairy Farms, Army Headquarters, Simla.
9. The Hon'ble Mr. E. F. Barber, Member, Legislative Council, Madras.
10. H. Moberly, I.C.S., District Judge, Coimbatore.
11. F. R. Hemingway, I.C.S., Collector of Coimbatore.
12. D. A. D. Aitchison, M.R.C.V.S., M.P.S., Principal, Veterinary College, Madras.
13. F. Lodge, C.I.E., Conservator of Forests, Coimbatore.
14. W. Smith, Assistant Director, Dairy Farms, Poona.
15. C. Drieberg, B.A., F.H.A.S., Secretary, Ceylon Agricultural Society, Peradeniya.
16. T. Southwell, A.R.C.S., F.Z.S., F.L.S., Deputy Director of Fisheries, Bengal and Bihar and Orissa, Calcutta.
17. Dr. W. F. Bruck, Professor, a. d. Universitat, Griessen, Germany.
18. W. McRae, M.A., B.Sc., Government Mycologist, Coimbatore.
19. F. R. Parnell, B.A., Government Botanist, Coimbatore.
21. E. R. Mahon, President, Planters' Association, Coorg.
21. G. R. Hilson, B.Sc., Deputy Director of Agriculture, Madras.
22. Rao Bahadur M. R. Ry. K. Rangachariar Avl., M.A., L.T., Lecturing Botanist, Agricultural College, Coimbatore.
23. Rao Bahadur J. Dharmaranga Razu Garu, Assistant Registrar, Co-operative Societies, Madras.
24. M. R. Ry. D. Ananda Rao, B.Sc., Assistant Director of Agriculture, Madras.
25. M. R. Ry. K. Ramasastrulu Naidu Garu, B. Sc., Assisant Director of Agriculture, Madras.
26. K. T. Matthew, D. Hy., D.P.H. (Cantab.), Deputy Sanitary Commissioner and Inspector of Vaccination, Madras.

PROGRAMME.

SUBJECTS DISCUSSED.

3. The programme before the Board consisted of the following subjects approved by the Government of India for discussion :—

I.—The Confirmation of the Proceedings of the last Meeting.

II.—The Programmes of Work of the Imperial Department of Agriculture and of the Imperial Bacteriologist.

III.—The Programme of Work of the Provincial Agricultural and Veterinary Departments and of Native States' Departments of Agriculture.

IV.—The best means of bringing improved methods of Agriculture to the notice of Cultivators.

V.—(*a*) Cattle-breeding and (*b*) Food and Fodder-supply. The best means of investigating the relative feeding values of Indian Cattle-foods.

VI.—How the energies of the Veterinary Department can best be utilized for the dissemination of preventives against cattle disease and the introduction of prophylactic measures.

VII.—The Indian Sugar Industry.

VIII.—Rice.—A preliminary discussion of the work already done in the various provinces on this crop and the consideration of a working scheme for future investigations so as to prevent over-lapping.

IX.—Agricultural Education.—A Sub-Committee will be appointed to review the Educational policy of the Department in the light of the experience already gained, and to make suggestions of such modifications as may seem desirable.

X.—The Dairying Industry of India.—How should the various scientific and commercial problems involved be attacked.

XI.—Soil denudation by rainfall, and drainage: Conservation of Soil Moisture.

XII.—Fruit Culture in the various Provinces.

PROCEEDINGS.

FIRST DAY.

Opening of Proceedings.

4. The first meeting of the Board was opened on Monday, the 8th December, 1913, by the Hon'ble Sir John Atkinson who, in welcoming the Board to Coimbatore, said :—

"Before the Board proceeds to the transaction of its formal business, I desire on behalf of the Madras Government to offer a very hearty welcome to all who have assembled in this—to some of you—distant spot. I myself am here in a dual capacity both as host and guest. My words of welcome must therefore be coupled with cordial thanks to those by whose labours this meeting, fraught with such possibilities for good, has been arranged.

"The selection of Coimbatore as a scene of your labours is, I think, an altogether happy one. No other spot could have been chosen with equal facilities for observing the more remarkable systems of South Indian Agriculture. In this Coimbatore District, where nature has been somewhat niggard of her favours, cultivation is intensive to a degree unknown elsewhere in the Presidency. Dry crops, wet and garden crops,—to use the Madras terms—alike illustrate the results that follow from the combination of intelligent experience with unflagging industry. And if these methods and results may be observed within a mile or two of where we sit to-day, no greatly extended journey is needed to bring you in sight of the totally distinct cultivation of the West Coast; or of the highly specialised processes in vogue on the planters' estates. But it is not only its central situation that makes the choice of Coimbatore for your meeting a peculiarly happy one, but no less the opportunity afforded you of studying the work of our Agricultural College and Department, of which we Madrasees are, I think justly, proud.

"In Madras there has been an agricultural college and experimental farm in existence since 1863. I am not going to indulge in a history of that venture though it turned out some good men, did some useful work, and also provided much experience. But a comparison of the old administration reports with those of recent years brings out some important differences. In the earlier days the reports referred chiefly to the introduction of exotics and to work on lines such as viticulture, and agave plantations, useful in themselves, but which did not affect directly the occupations of the bulk of the cultivating classes. The hobby of the moment changed every few years. The district staff at the disposal of the department was small, and there is little or no reference in those reports to the adoption of improvements by the ryots. But since 1907-08 the reports refer chiefly to paddy, cotton and sugarcane, three crops which represent 40 per cent. of the total cultivated area of the Presidency. And in every report the references to the adoption of new methods, and to the sale of better seed occupy continually more and more space. The methods and programme of work in this Presidency will come in review before you and I would not dream of attempting any comparison of the work done in the various provinces. Even if I wished to do so, I could not, and I have no desire to make the attempt. But although the Madras Agricultural Department has not achieved everything in a moment, it has shown that the scepticism with which its development was viewed in some quarters in 1905-06 was unfounded and needless. Better types of sugarcane have supplanted older and worse varieties in Godavari, South Canara and South Arcot. Eight years ago pure *Karunganni* cotton was only obtainable in a few villages of Tinnevelly; now, thanks to the system of seed farms, there are in that district more than 50,000 acres under that variety. In Kurnool round Nandyal the mixture of crops in the field was still worse, but, the Manager of the Mills which use Nandyal cotton most largely has recently commented upon the steady improvement in the quality of the cotton from that neighbourhood. Thanks largely to the vernacular papers, to the work of associations, and to constant touring, single seedling transplantation of paddy is spreading rapidly, though at present it is very far from being universally adopted. The annual value of the savings in this Presidency due to this method may ultimately

be reckoned in crores of rupees. These results compared with the results from the efforts of twenty and thirty years ago justify to my mind the soundness of the recommendations made by your Board at the meeting at Pusa in 1908 that attention should be devoted rather to the investigation of the cultivators' actual wants, than to the recommendation of unfamiliar and untried methods, and that concentration of work is of first importance.

"This subject I am glad to see is again before the Board and it will be approached with a longer and more detailed experience than was possible in 1908.

"I do not propose to go through all the subjects you have down for discussion. That is for the President. But on five of these, *viz.*, Nos. V, VI, VII, VIII, and IX this Government will look to your report with special interest. A cattle survey has been completed in this Presidency and the papers are before the Government. As to education, I understand, that whilst there is no lack of applicants for admission to this College, and whilst the students leave the College with a satisfactory equipment of knowledge, the numbers passing through the College are insufficient. It seems doubtful whether all require the same training. If you are drawn into the attractive but difficult field of vernacular education, I would only say that it is necessary to keep local conditions well in mind. This subject of education ought to be approached with greater confidence than on earlier occasions on account of the experience you possess.

"Dairying is a wide and difficult problem. An enquiry into the methods of dairying in Madras City elicited the reply from one dairyman that he 'bought his milk from the milkmaids of Madras and worked it up on scientific principles.' I do not like to try to imagine what strange process was necessary after 'the milkmaids of Madras' had finished with the milk.

"It only remains to beg your indulgence for any shortcomings in the entertainment provided for you. These meetings might have been held in greater physical comfort in Madras, but it appeared more seemly to invite you to Coimbatore which as I have already said in many ways is the centre of our agricultural activities. The local officers will, I am sure, be very glad to show you anything of their work here or in the districts, or of the local agricultural practice, and would be very pleased after the meetings are over to take any of you who may so desire to any of the local farms. The Planters' Association has very kindly offered to show to you some South Indian Estates if any care to see them—Tea, Coffee or Rubber.

"I hope to have the pleasure of seeing many of you personally during the course of this week and meanwhile trust that you will find your discussions both pleasant and profitable."

5. The President followed with the following address in which he touched on the action taken on the recommendations made by the Board in 1911, and on the subjects for discussion at the present meeting:—

"In opening the Eighth Meeting of the Board of Agriculture in India and in welcoming so many members and visitors, my first duty is the pleasing one of expressing our thanks to the Government of Madras for so kindly extending their hospitality to us and to the Hon'ble Sir John Atkinson for the gracious terms in which he has proferred that hospitality. My next is to express what, I am sure, is the general regret that His Excellency the Governor is unavoidably unable to be present at any of the meetings. Those of us who know what Lord Pentland did, as Secretary of State for Scotland, for the development of agriculture in that country will, I am sure, understand that it is only the most pressing necessity that prevents His Excellency from giving the recognition of his official attendance to our meetings: and I am sure it is as much a matter of regret to him as it is to us that he cannot be with us.

"Amongst the many distinguished visitors who are attending our meetings I would, in particular, welcome the Hon'ble Sir Robert Carlyle, our Member in the Government of India, the Hon'ble Sir John Atkinson, Member of the Council of the Governor of Madras, and the Hon'ble Sir Alfred Bourne by whose ripe experience as an Educationalist we hope to benefit.

"Gentlemen, since the last meeting of the Board at Pusa, in November, 1911, many important changes have taken place to which I may perhaps be allowed to refer briefly.

"In April, 1912, the post of Inspector General of Agriculture in India was abolished and the new appointment of Agricultural Adviser to the Government of India was combined with that of Director of the Pusa Research Institute. The services of Mr. Coventry, our Agricultural Adviser, who, you will all be glad to hear, will be back at the end of February, received high recognition when, in June, 1912, he was appointed a Companion of the Indian Empire. As a further distinction conferred upon the Department, I have to record the bestowal of the Kaiser-i-Hind gold medal on that distinguished lady worker—Mrs. Howard—whose absence from our meetings on account of ill-health, we all regret.

"In December, 1912, the Department suffered a heavy loss by the resignation of Mr. H. M. Lefroy, the Imperial Entomologist. Mr. Lefroy was an enthusiast in his subject, who added to a remarkable energy in original research a due appreciation of the economic importance of his subject, and his work has left a marked impression on the country and has materially enhanced the reputation of the Agricultural Department.

"Since the last meeting there has been a considerable expansion of our superior staff. The territorial re-distribution in Bengal has been followed by the creation of a Department of Agriculture in Assam and a distribution of existing staff amongst the three provinces as re-constituted. This has necessitated the recruitment of another Agricultural Chemist. Dr. Barber has been appointed Sugar Expert with headquarters at Coimbatore. Mr. Hulme has been appointed Sugar Engineer in the United Provinces: a post of Entomologist has been added to the cadre of the Madras Department, which has also been strengthened by the addition of a third Deputy Director. An Assistant Botanist has been appointed in the United Provinces. A Third Deputy Director and an Assistant Director of Agriculture have been sanctioned for the Central Provinces: a Second Deputy Director of Agriculture for Bihar and the Punjab: while further additions to the staff are under consideration for Bengal, the Punjab, the United Provinces, Bombay and Bihar and Orissa. Finally, Agricultural Engineers have been added to the staff in Bombay and the United Provinces.

"Before proceeding to introduce the Programme for discussion at the present Board it may be convenient to pass in brief review, the action which has been taken on the Resolutions of the last Meeting of the Board held at Pusa in November, 1911.

"The Government of India accepted the Resolution of the Board that future Meetings should be held every two years, alternately in one of the Provinces and at Pusa: and, consequently, we are now meeting in the Madras Presidency. The Government of India has also accepted the recommendation of the Board that Honorary Degrees of L. Ag. should not be conferred and decided that such degrees should be awarded only to those who have gone through the prescribed three years' curriculum at an Agricultural College.

"I regret that, up to the present, it has not been possible to give effect to the Resolution of the Board that the relative feeding value of food stuffs and fodder for cattle should be made the subject of an early study at Pusa. The subject in all its aspects will come up again for consideration this year under Subject V, and I hope that some practicable working scheme will be evolved.

"The important subject of Cotton Investigation in India bulked largely in the Proceedings of the last Board—an able note on the subject by Mr. Coventry being taken as the basis of discussion. The general principles laid down in this note were endorsed by the Board, and, as a result, the extension and improvement of cotton cultivation in India on the main lines indicated in the Report or the Progress of Agriculture in India for 1911-12, have continued to engage the chief attention and time of the Agricultural Department in all Provinces where cotton is a crop of importance. The staff of Deputy Directors is being increased: unremitting attention is being paid to the selection of seed, demonstration of improved methods of cultivation, maintenance and distribution of seed of improved varieties, evolution of new types by plant-breeding and other processes. Seed farms are being multiplied, and every possible inducement is being given to cultivators to grow improved varieties.

"In this connection we hope, later in the week, to welcome as a visitor to the Board, Mr Arno Schmidt, the energetic Secretary of the International Federation

of Master Cotton Spinners' and Manufacturers' Associations. I hope that his presence at the Board may prove to our mutual advantage.

"Another important subject which engaged the attention of the last Board was the Indian Sugar Industry. The recommendations made by the Sub-Committee which dealt with this subject have formed an excellent guide for local Governments and Administrations in framing their policy. In consequence, much attention has been devoted to this crop during the past two years and the progress made in each Province will, I have no doubt, be fully recorded by the Committee which will this year deal again with the subject. I shall not anticipate the report of that Committee by entering into details.

"It seems unnecessary to refer further to the Resolutions of the last Meeting of the Board as they, in the main, dealt with general principles; but it is satisfactory to note that, in all cases, these recommendations have, as far as possible, been given effect to by Provincial Departments in shaping their policy of agricultural development.

"I shall now briefly direct your attention to the subjects for discussion at the present Meeting. Subjects II to IV might be called the "*hardy annuals*" of the Board's agenda, but the terms of reference under each of Subjects II, III and IV will show that there are this year very important points to be determined. Under Subject IV, I trust that the growing relationship between Agriculture and Co-operation will be duly emphasised and that, so far from being merely a record of progress, the report of this Committee may be able to lay down for us, with some measure of definiteness, the lines upon which the agricultural and co-operative movements can be linked together. Co-operation, even in India, is not solely dependent upon agriculture for its energies: there are many trades and industries to the assistance of which its efforts could suitably be directed. But the population of India is preponderatingly agricultural and the force of circumstances and environment has naturally directed co-operative effort first to agriculture. In a land of small holdings like India it is practically the only means by which scientific agriculture can be made possible, and it, therefore, is the duty of an Agricultural Department to see how it can best utilise this great aid which has been placed to its hand.

"Subjects V and VI remind us that, for the first time—in the history of the Board, we welcome our colleagues of the Civil Veterinary Department. The subjects which we offer for their consideration are general, being concerned with problems that are common to both Departments and, in a large and mixed Board like this, it is difficult to do otherwise. At future meetings of the Board it may be possible to include one or two subjects of more technical interest which can be discussed by Veterinary Officers themselves. But the two which we have selected for discussion this year are practical problems which concern both branches of the Service and in which both parties can co-operate for their mutual benefit.

"Under subject VII—The Indian Sugar Industry—the Committee will review the progress since the last meeting of the Board and will make such further recommendations for development as they may consider advisable.

"To certain provinces of India the rice crop is one of first importance. In Burma, it is the greatest export crop, no less than 2,500,000 tons being annually exported: in Bengal, Madras, the Central Provinces and parts of Bihar and Orissa it forms the food crop of the great bulk of the population. It will perhaps be impossible to get, from a discussion of the crop, such precise conclusions as we have in the past been able to promulgate with reference to such crops as cotton, wheat or tobacco. But there is a general feeling that the crop should, sooner or later, be considered, and the meeting of the Board in one of the great rice-growing provinces seemed a suitable occasion for opening the subject.

"Perhaps the most important subject which will engage the attention of the Board is the question of Agricultural Education. This question has engaged the anxious attention of the Department ever since its initiation. We have had some successes, but, we must, I am afraid, admit that we have also had some failures, and, just as a good business man does not shirk the task of taking stock even though he may have a feeling that all is not well, so it is but right that we should now, after our few years' experience, review the situation and see whether our policy is built on a sound foundation or not. I hope for a very full expression

of the opinion of the Board on this most important subject and I trust that the result of our deliberations will be to amend what has been found to be wrong and to reconstruct our policy of Agricultural Education, if necessary, on a sound and firm basis.

"Another very important subject which will engage your attention is that of the Dairying Industry of India. The supply of a plentiful quantity of good pure milk is one which is engaging, to a very great extent, the attention of the Municipal and Medical authorities. Dealing as we do with the cattle of India we cannot get away from the fact that the responsibility for the provision of such a supply rests more or less with us. It is not improbable that the results of our deliberations will be to show that the first necessity is the provision of an adequate supply. Till this is forthcoming it would perhaps be premature to enter into much detail as to the scientific aspects, such as the Bacteriological or the questions of *ghee* and butter manufacture, etc.; but all these points will, I have no doubt, be borne in mind by the Committee.

"With reference to the next subject, *viz.*, Soil Denudation by rainfall, and drainage, and the Conservation of Soil-moisture, I am extremely sorry that Mr. Howard who devoted a portion of his recent leave to the investigation of this subject in Italy is unable, owing to Mrs. Howard's illness, to be present at this discussion. He has, however, kindly sent me an opening note which will form the basis for discussion by the Committee. In some parts of India, *viz.*, those which enjoy a steady monsoon, there is no doubt that the problems of drainage are, if not of greater, at least of equal importance, to the question of irrigation in our dry districts; and I venture to hope that the discussion of this subject at our Meeting may direct the attention of the Agricultural and Engineering Departments to the importance of this aspect of the question.

"The last subject on the programme is Fruit Culture in the various Provinces. A great amount of success, both in the growth and packing of fruit and in the transportation and other business arrangements connected with the industry has been achieved by the Howards in Quetta and also by Mr. Robertson-Brown at Peshawar. The question is one which is now being generally taken up by Agricultural Departments, and I think that it may be of mutual advantage if the workers on this subject have an opportunity of discussing together the various points connected with the industry.

"Gentlemen, it will be nine years next January since the first Meeting of the Board of Agriculture, as we at present know it, was held at Pusa. In these nine years much progress has been made. The superior staff of the Department has been increased from 30 members to 78, the number of farms from 40 to 259. But there has been more than mere numerical progress. There has been progress in Education and Co-operation on both sides. On our part we have got beyond the stage of considering that the East has nothing to teach the West. We have learned that we have to deal with an agricultural practice which is built on the traditional custom of years and in which reside, though unexpressed and unexplained, deep scientific principles, the reasons for which are only gradually being elucidated. We have found that the only way to progress is a sympathetic appreciation of local conditions based on an accurate study of indigenous methods (for which a good knowledge of the language is essential) and a sympathetic co-operation with the cultivator. Unless we have the sympathy and co-operation of the cultivator we can do nothing. Compulsion and force are absolutely opposed to the idea of agricultural development. The adoption of the methods we recommend is a purely optional matter. The cultivator need not take them up unless he wants to: and he certainly will *not* do so unless he is firmly convinced that they are better than his own. Fortunately we have been able in many cases to persuade him that they are: the days of suspicion and mistrust are gradually passing away and with the cordial and increasing co-operation of the cultivator, I think, we may say that we have really begun to effect something.

"Simultaneously with the development of our mutual understanding of each other—that great factor in all schemes of economic development—the co-operative credit movement, has been gaining in strength. It provides the lever which lifts the small man out of his narrow and restricted environment and enables him, by the power of combination, to throw off the disabilities of his restricted village commerce and to enter on more equal terms into the business of the wider

market places of the world. It is most opportune that the movement should have gained ground in India simultaneously with the forward movement in agricultural research. It is the one great factor which brings the adoption of the most approved methods, expensive though they be, within the reach of the small cultivator who is the backbone of the agricultural wealth of India.

"Gentlemen, particularly fortunate and happy are those who, like the members of the Indian Agricultural Service, can take a share, however humble, in the economic development of this great Empire. For a contented rural population means a satisfied and peace-abiding nation. Yours it is in peculiar measure to work in peaceful harmony and trust with the people amongst whom you are placed: no suspicion or mistrust arises as to the integrity and honesty of your intention: you are working with the people and for the people for the people's good. You are now ploughing no lonely furrow. The numbers of your fellow workers are daily increasing and, if sympathy and co-operation are the key notes of your action, then, when you come to lay down the plough, at the termination of your career in India, you can lay it down and leave the country with, at least, the gratifying testimony of a good conscience."

SUBJECT I.—CONFIRMATION OF PROCEEDINGS OF THE LAST MEETING.

6. After the Proceedings of the last meeting were confirmed, Committees were appointed to deal with subjects II to XI and the Board adjourned for the Committees to deliberate.

THIRD DAY.

7. The second meeting was held on the 10th December, 1913.

In view of the fact that those members of the Board who belong to the Veterinary Department were interested only in some of the references under subjects II and III, and in subjects V and VI, the President requested the Board to take up these references first, so as to set Veterinary Officers free to return to their head-quarters.

The Committee on subjects II and III (Veterinary) consisted of Mr. Heycock (Chairman), Colonel Pease, Major Smith, Messrs. Harris and Ware.

SUBJECT II.—(VETERINARY): PROGRAMME OF THE IMPERIAL BACTERIOLOGIST (APPENDIX A, PAGE 58).

8. The terms of reference were:—

To examine how far the programme meets the requirements of the Provinces.

Mr. Heycock read the report of the Committee which was as follows:—

"The Committee consider that the Programme of Work of the Imperial Bacteriologist should contain a statement showing the main work on which he is engaged, *viz.*, the preparation of sera and vaccines. As it does not do so, it is impossible to say how far the present programme meets the requirements of Provincial Officers with regard to the preparation of sera and vaccines."

With reference to this criticism of the Programme of Work of the Imperial Bacteriologist, Major Holmes explained that the Programme related to research work only and that other particulars were given in the Annual Report.

Mr. Heycock said that the Committee thought that there should be a definite forecast of the quantities of sera likely to be available.

Major Holmes having pointed out that though as many doses as possible would be prepared, it was not possible to make a forecast of the kind suggested, the President gave it as his opinion that the report was on the lines required.

A resolution to the effect that the Board should not accept the Committee's report was proposed by Mr. Dobbs and seconded by Mr. Harris who explained that he had changed his mind since signing the Committee's report.

The question was put to the vote and, on a division in which only 15 members of the Board participated, was negatived by a majority.

The report was thus **accepted by the Board.**

SUBJECT III.—(VETERINARY): PROGRAMMES OF WORK OF THE PROVINCIAL DEPARTMENTS (APPENDIX B, PAGES 59—103).

9. The terms of reference were:—

(a) *To consider how far the programmes of the several Provincial and Native States' Departments meet the requirements of the Imperial Officers and of the other Provinces and States.*

(b) *To examine and report how far the recommendations of Committee A of the Board of 1910, printed on page 80 of the proceedings and passed by the Board, have been followed in drawing up the programmes.*

In this connection the Resolution of the Board of Scientific Advice at its 22nd Meeting on the necessity of drawing a distinction between major and minor investigations will be taken into account. This resolution was in the following terms:—

"RESOLVED.—*To recommend that those departments that so far have not differentiated between the more and the less important investigations claiming attention, should in future do so and that programmes should distinguish between main and subsidiary lines of investigation accordingly.*"

10. Mr. Heycock read the report of his Committee as follows:—

"The Committee notice that no programme has been received as yet from the Superintendent, Civil Veterinary Department, Bengal.

This is the first year Veterinary officers have been asked to submit programmes for the information of the Board of Agriculture. The instructions prescribing the form in which programmes should be submitted appear to be open to misinterpretation, judging from the different nature of the programmes sent in by the various Provinces. Having regard to the nature of the programmes submitted, it is not possible for the Committee to estimate how far they satisfy the requirements of Imperial and other Provincial officers. The programmes, the Committee think, should in future years contain the following particulars:—

A note showing the size of the staff, number of hospitals and dispensaries, progress made since the last report and the chief problems which are engaging the attention of the officers of the Department concerned, such as the difficulties of training and recruitment, horse and cattle breeding, prevalence of particular diseases, etc.

If an officer is engaged on any special work, his programme should separate distinctly major and minor investigations. He should also distinguish between work in progress and new work, giving information as to—

(a) its aim;

(b) the results, if any, obtained since the submission of the previous programme;

(c) the direction in which it is proposed to continue the work during the current year."

With regard to the particulars specified by the Committee for mention in future reports, Mr. Blackwood said that it had been understood that only scientific work was to be referred to in Programmes, and that administrative questions were not involved.

The President thought that the points mentioned in the report provided a good skeleton for a programme and that the mention of staff was justified as conditioning the nature and amount of work possible.

The Board unanimously agreed to the acceptance of the Report which was proposed by Dr. Leather and seconded by Mr. Dobbs.

SUBJECT VI.—HOW THE ENERGIES OF THE VETERINARY DEPARTMENT CAN BEST BE UTILIZED FOR THE DISSEMINATION OF PREVENTIVES AGAINST CATTLE DISEASE AND THE INTRODUCTION OF PROPHYLACTIC MEASURES.

11. This subject had been considered by a Committee consisting of Mr. McSwiney (Chairman), Colonel Evans, Lieutenant-Colonel Farmer, Major Holmes Messrs. Clayton, Oliver, and Quinlan.

The terms of reference were :—

> *To consider the Resolution passed at the 6th Conference of the Registrars of Co-operative Societies to the effect "that cattle insurance should not be undertaken unless adequate means existed of applying prophylactic measures", and to make recommendations.*

Mr. McSwiney read the report of the Committee appointed to deal with this subject, which report as finally adopted is printed on page 13.

As to the form of this report, the Board agreed to a suggestion of Dr. Leather's that the proposers and seconders of resolutions moved in Committee, need not be mentioned in the report.

A suggestion made by Mr. Ram Gopal, and understood to mean that the Veterinary Department should open elementary courses in Hygiene suitable for *Patwaries* and *Lambardars,* found no other supporter.

Mr. Ram Gopal subsequently explained that he had only intended to suggest the drafting of such courses.

As regards inoculation Dr. Pillai asked whether Government would not undertake to supply sera to Native States, and Major Holmes explained that this was already done where a trained assistant was available in the State to carry out the inoculation.

With regard to the third paragraph of the report the President mentioned that the Government of India was already thoroughly acquainted with the situation and asked Major Holmes to explain to the Board. Major Holmes having explained the circumstances in connection with the break down of the new centrifuges at Muktesar, Colonel Pease proposed the deletion of the paragraph from the report. This proposal was seconded by Mr. Fletcher but rejected by a majority on a show of hands.

Coming to paragraph 4, the Chairman of the Committee asked Mr. Clayton to explain the position. Mr. Clayton said that it had been suggested that nothing could be done towards the insurance of cattle until their inoculation was possible. The Committee was, however, of opinion that inoculation was only an adjunct and that the main consideration was the spread of education as to hygiene and proper feeding and this was difficult owing to a general absence of public spirit and public opinion, one man not caring what happened to another man's cattle. The creation of such a public opinion was one of the great advantages of Co-operative Societies whose members would heed the warnings of an inspecting official as isolated individuals would not.

Dr. Mann contended that the idea of the Registrars in passing the resolution referred to was that it was necessary to enforce inoculation in order to prevent the premium for insurance rising so high that no one could pay it.

Mr. Clayton pointed out that the premium was an automatic indicator of the value of insurance, the principles of sound insurance applying independently of the rate of mortality. Insurance had been most successful in five districts in the dry zone of Burma where cattle were stall-fed. The rate of premium had been worked out there and about 40 Societies started were doing well. Very little mortality had occurred and insurance was certainly easier where mortality was low.

In reply to Mr. Sampson, Mr. Clayton said that the cattle were valued by a Committee of the Insurance Society after hearing the owner's valuation. Three-fourths of the valuation fixed was paid.

Colonel Maxwell pointed out that when inoculation only gave protection for three months, its general adoption was of very little use, and suggested making it compulsory in infected areas only.

Mr. Smart thought that if this had been brought out at the Conference, the Registrars would not have passed the resolution. They had thought protection necessary against the possible ruination of Societies, suggested by Mr. Coventry, owing to the prevalence of the cattle disease. If there were a staff to carry out inoculation in emergencies, the danger would be minimised.

Colonel Evans said Co-operative Societies were already responsible for reporting outbreaks, which met the difficulty.

Dr. Mann asked whether the Veterinary Department had data of mortality to enable the possibilities of insurance in defined areas to be worked out and Mr. Clayton replied that statistics for five districts in Burma showed a 2 per cent. mortality. The rate of premium to be prescribed has been fixed by the Registrar at 5 per cent., thus leaving a wide margin of safety should the statistics prove to be unreliable. Co-operative Societies can themselves provide the most accurate data, and insurance would break down at once if not on a sound basis, necessitating the automatic raising of the premium.

After some discussion of the difference in mortality rates according to the class of cattle to be insured and the uses to which they were put, Mr. Clayton explained that there were in Burma no insurance societies unconnected with Co-operative Societies and that the agricultural methods and the way the cattle insured were used were thoroughly well known to the Registrar's staff—such knowledge being essential to the financing of the society.

The Board adopted unanimously **a resolution** proposed by Mr. Smart and seconded by Colonel Maxwell, **to add to the fourth paragraph of the report the words "and to raise no objection to the establishment of co-operative cattle insurance societies where the Veterinary Department can guarantee facilities for inoculation on the outbreak of disease".** Res

The President, who had been the Chairman of the Committee of Registrars, explained that he had not approved of the resolution referred to, which had been put in its proper perspective by the present Committee's report.

The Board accepted the report as below :—

Inoculation, though very important in dealing with contagious cattle disease, is chiefly valuable as an adjunct to the other methods, and that the best method of prevention is by the instruction of the people in the proper care of their cattle, sanitation, storage of forage, water supply and prompt and effective segregation on the outbreak of contagious disease and early reporting of the same.

As a result, the first duty of the Veterinary staff of each Province, both superior and subordinate, is to get into the closest touch with, and to obtain the confidence of, the people in their village.

2. In the above circumstances the Committee are not prepared to recommend the general acceptance of the principle of extending inoculation by unqualified men, as the people would be more suitably taught to use other measures ; they were of opinion that progress would best be achieved by an adequate increase in the superior and subordinate staffs of the Veterinary Department.

3. The attention of the Government of India should be drawn to the fact that opportunities of inoculation have been lost owing to the failure of the supply of serum from Muktesar for several months past and that the Board of Agriculture should urge that the Imperial Bacteriologist be placed in a position to meet the demand.

4. Inasmuch as a centralised department is at a great disadvantage in undertaking propaganda for improved methods, either of Agricultural or Veterinary practice, among an unorganised population, this Committee would welcome the establishment in every Province of a system of cattle insurance on co-operative lines as the best means of creating a strong public opinion in favour of improved cattle hygiene, and would express the hope that the Registrars of Co-operative Societies may see their way to re-consider the resolution come to at their sixth Conference, and to raise no objection to the establishment of co-operative cattle insurance societies where the Veterinary Department can guarantee facilities for inoculation on the outbreak of disease.

Subject V.—(a) Cattle-Breeding and (b) Food and Fodder Supply. The best means of investigating the relative feeding values of Indian Cattle-Foods.

12. This subject was considered by a Committee consisting of the Hon'ble Mr. Hailey (Chairman), Colonel Pease, Lieutenant-Colonel Farmer, Dr. Parr, Messrs. Evans, Hamilton, Sitole and Smart.

The terms of reference were :—

(a) *A survey of the cattle-breeding industry has been made or is in progress in most provinces and the time would now seem ripe for the Board to advise on the lines of future policy to be adopted. The measures to be taken for the preservation of the fine breeds which already exist and the protection of the cattle-breeding industry, the preservation of grazing areas, and the general question of fodder-supply (together with the*

implied one of grazing versus *stall-feeding*) *seem to call for further discussion. In view of the growing opinion in favour of stall-feeding, is it now desirable to start a systematic investigation of the relative food values of Indian cattle-foods and to frame a working plan for this, on the lines of combined feeding and chemical tests ?*

(*b*) *To consider the suggestions made by the Board of Forestry at their Meeting in March 1913 :—*

"*It is considered desirable that the Agricultural Department should be asked to continue experiments as to the possible utilisation of prickly pear for fodder ;*" *and*

(*c*) *to make recommendations.*

Mr. Hailey read the report * of the Committee on Subject V and apologised for the necessary inadequacy of a short report on so wide a subject. He said that though the subject overlapped with subject X (Dairying), the Committee had studiously avoided that aspect of it.

The President after thanking Mr. Hailey for his excellent report mentioned the discussion of the subject at the Forestry Board's recent meeting and read extracts from the Government of India's letter in which they expressed to local Governments their views on the resolution by that Board with special reference to the question of substituting cut fodder for grazing and of utilising prickly pear as a fodder.

Mr. Hailey explained that it was in view of these references that the Committee had laid what might otherwise appear to be undue stress on certain points in their report.

As regards increase of grazing area being necessary for the improvement of cattle, Mr. Lodge said that the result in some cases had been deterioration, and that restrictions should be imposed so as to keep the numbers of cattle on grazing areas, within limits. He mentioned experiments in selling hay, which had been popularised by offering it for sale and said that by cutting coarse grass the growth was greatly improved. *Lantana* destroyed pasture land, which recovered its value after eradication of the pest. He endorsed the principle of establishing an agricultural branch of the Forest Department, if the increase of staff could be obtained.

Mr. Hailey thought that a scheme tried on the United Provinces ravine lands was likely to become a great success. *Babul* planted on large areas for tannery purposes had the result of largely improving the grazing, and Forest Officers in fact maintained that no great growth of grass ever took place on such areas without some shading by trees. The area, 10,000 acres to begin with, now extended to a much larger area and gave a magnificent growth of grass. No general advance was, however, possible until a branch of the Forestry Department was formed for dealing constructively with these ravine areas. Already there were a Forest Officer and special staff in the United Provinces.

With reference to the question of preservation of grazing grounds, Mr. Sampson suggested, in the interests of Madras that it was undesirable to recommend the exemption of any grazing lands, forest or otherwise from restrictions, except in recognised grazing tracts.

Mr. Smart objected that, in Bombay, there was, he believed, only one recognised grazing tract outside Native States, and the adoption of Mr. Sampson's proposal would mean approval of restrictions on grazing almost anywhere in the Presidency.

After some discussion in which Mr. Chadwick and Colonel Pease took part and from which it appeared that Mr. Sampson's chief objection to unrestricted grazing was based on the evil effects of over-stocking small grazing areas such as are common in Madras, Mr. Hailey explained that the intention of the Committee had been to avoid restrictions as much as possible. He proposed to limit the

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* The report as amended is printed on pp. 15 to 17.

scope of the paragraph dealing with this question to forest areas, but to add to the end of the first sentence the words "except in such areas as are regarded as already over-stocked."

Mr. Chadwick accepted the paragraph as thus amended, the discussion having sufficiently emphasised the difference of conditions in different provinces. With reference to the improvement of waste areas he would like to see an account published of the interesting work in the United Provinces referred to by Mr. Hailey.

Mr. Hailey said he believed a special report dealing with the matter was being brought out. In reply to the President, he said that it was not suggested that the Board should give any special prominence to the Committee's suggestion under this head.

The Board then went on to discuss the last of the Committee's recommendations. The large number of cattle of a similar class, required for conducting practical feeding tests, having been pointed out by Mr. Dobbs and emphasised by Colonel Pease, Mr. Milligan said that in two or three years' time it might be possible to start experiments of a practical nature at Pusa. Mr. Clouston said they had already established the value of one of the grasses in the Central Provinces and of cotton seed and cake by feeding experiments with young animals in a breeding herd. Mr. Wood illustrated the difficulty of dealing with the matter on ordinary farms by quoting the contradictory results arrived at by him with working bullocks. In reply to Dr. Leather, Colonel Pease explained that the Committee had contemplated as well, more scientific and elaborate tests with apparatus of the kind used in Germany and America. Mr. Meggitt drew the Board's attention to the necessity for distinguishing between the many different kinds of proteins in analyses in connection with this kind of work. Dr. Fischer had distinguished a large number of chemically distinct proteids which had been shown to have very diverse physiological effects. Dr. Butler emphasised the enormous difficulties involved in an attempt to get any results of any value from experiments on nutrition of the kind proposed, and instanced alcohol as one of the few substances the nutritive value of which had been satisfactorily determined in this manner.

Colonel Pease explained that the general feeling of the Committee had not been that the subject was of the importance implied by the wording of the recommendation, and suggested the substitution of the word "desirable" for "absolutely necessary,"—which was accepted. As regards foods of general importance, such as cotton-cake which Mr. Hamilton specified as a food the value of which required to be established in the Punjab, it was pointed out by several members of the Board that the question is one more for general demonstration of a recognised fact than for more precise experimental determination.

The President drafted **a resolution** which was proposed by Mr. Dobbs and seconded by Mr. Hailey, **"that the Board endorse the report of the Committee and agree that only general principles can be laid down.** RES

With reference to the investigation of the relative values of Indian cattle-foods, they consider that a scientific investigation could only be carried out by a special staff with special equipment such as could not at present be justified by the comparative importance of the results likely to be obtained." This resolution **was accepted by** a majority of **the Board.**

13. The report as amended is given below ;—

"In dealing with the subject of the cattle supply of the different provinces of India, there is one outstanding feature common to all, viz., the rising price of cattle. The main reasons for this are variously stated to be the extension of cultivation and consequent restriction of grazing lands; the marked falling off in importations from Native States; the increased cultivation of commercial crops such as cotton and jute which have led to a decrease in the cultivation of crops affording fodder with the necessary result that cultivators in these tracts have come to rely more and more on purchases from the breeding districts. The latter cause is said to operate so largely in some areas that the cultivator is content if he can support his plough cattle. The position in some parts of India, notably the Bombay Presidency, appears to be such that before any project in the direction of improving the quality or increasing the number of cattle can be attempted efforts must first be made to ensure an adequate supply of fodder. It is pointed out that it is of little use providing the services of better classes of bulls if the cultivators are unable to rear the young stock. Cattle are bought yearly for the working season and promptly sold because there is insufficient fodder

to keep them alive in the open season. In such areas therefore the problem is rather that dealt with in the second subject of reference, *viz.*, Fodder-Supply.

There are, however, clear indications in each of the provinces represented on the Committee that the evil is bringing about its own remedy and that private enterprise is being stimulated by the considerable profits obtainable from cattle-breeding to make good the deficiency in the cattle supply. In addition to this the cultivators, particularly in the United Provinces, are being forced by the necessities of the situation so far to change their crop system as to include some form of fodder crops and to pay attention to the rearing of their young stock by stall-feeding. Some such outcome of the rise in prices of cattle is inevitable. The drain on the breeding centres has become so severe that the price of cattle is eating seriously into the profits of such cultivators as rely exclusively on them for their plough cattle. Sooner or later those who have been tempted by the growing prices of commercial crops to reduce the area under fodder producing crops must be compelled by the price of cattle to breed or rear cattle themselves.

The problem before the Agricultural Department is to assist them to become more self-supporting in this matter and also to assist and encourage the breeder to raise more and better animals.

In making their recommendations on the subject the Committee wish to make it clear that they draw a distinction between the breeding tracts and those tracts which are mainly dependent on outside sources. The main problem in the latter is the increase of the fodder supply and there is at present little possibility of effecting any improvement in cattle-breeding until this has been effected.

In this connection, however, it would appear desirable that some efforts should be made to work out in a non-breeding tract the relative profit and loss of (*a*) growing sufficient fodder and rearing young stock and (*b*) putting the land under cotton or other commercial crop and buying mature bullocks.

With reference to the first portion of the terms of reference, *viz.*, cattle-breeding, the Committee consider that the undermentioned points are of particular importance :—

(1) *Preservation of grazing grounds in forest areas.*—The restriction of grazing rights now enjoyed is from the point of view of cattle-breeding to be deprecated except in such areas as are regarded as already overstocked. There still remain in some provinces grazing lands of considerable extent which serve as breeding grounds. There is a danger that these may be encroached upon either for cultivation or as protected forests not open to grazing. The conditions differ so greatly that no specific recommendations can be made. The maintenance, however, of breeding grounds is of such importance that if there is any danger of their being devoted to other purposes their acquisition on public grounds appears desirable. If acquired they could be much more efficiently managed than at present, and could be made to support larger herds of cattle.

(2) *Improvement of waste areas.*—The improvement of these areas should be systematically undertaken with a view to increasing grazing and fodder facilities. In every province there appear to be large areas capable of development under proper management. The Committee recommend action on the lines now being taken in the United Provinces to bring the ravine areas under control on a large scale and develop them as fuel and fodder reserves. Such work of improvement can be best undertaken by the Forest Department acting in close association with the Agricultural Department. A separate branch of that Department might be formed under the title of Agri-Forest branch. The gradual afforestation of ravines and other waste lands would more than counterbalance the loss in grazing land from extension of cultivation. It is important that the aim in view should be primarily to increase grazing facilities and provide more fodder and should be regarded from this point of view rather than from that of increasing the forest area.

The object might possibly be attained by placing this work immediately under the civil head of the district. A somewhat similar system of improving the grass in certain high lying areas of hard soil by the formation of *kiaris* has been successfully demonstrated in the Punjab.

(3) *Increase in number of cattle-breeding stations.*—The number appears to be wholly inadequate in nearly all provinces. It is desirable that these farms should be located in breeding districts where there is likely to be a demand for bulls.

(4) *Maintenance of indigenous breeds of value.*—There appears to be a distinct danger of valuable indigenous breeds dying out through indiscriminate and careless methods of breeding. It is most essential that where this is the case separate farms should be devoted by Government to maintaining the purity of these breeds.

(5) *Breeding tracts.*—Certain definite tracts should be recognised as breeding tracts and effort at first concentrated in these areas. Additional staff should be attached to the selected tracts, who will devote themselves to the question of the supply of bulls, the regulating of breeding, advising as to rearing, etc.

(6) *Distribution of stock from the Government farms.*—The committee are not in favour of maintenance of bulls by district boards. It is essential that the cattle-owners should have a personal interest in the proper care of the bulls. Some such measures as those followed in the Punjab might be adopted where in the event of the superintendent of the circle approving of a bull being made over to a village or co-operative society, the district board bears part of the cost, subject to certain conditions as to the animal being properly cared for. In the Central Provinces bulls from the Government farms are distributed to certain *malguzars* who apply, on condition that they open breeding farms and carry out certain definite rules regarding their proper management. Co-operative Societies should be given every encouragement to maintain bulls for the benefit of their members.

(7) *Cattle shows.*—These have proved of very doubtful utility. Breeding could be better encouraged by giving prizes to groups of villages for young stock bred from bulls supplied by the Government farms.

(8) *Elimination of undesirable male stock.*—In certain parts of India the letting loose of Brahmani bulls forms a great impediment to any improvement in the breed of the local cattle. Experience has shown that as facilities for obtaining the services of better bulls are increased the villagers show a desire to get rid of these animals. Pious Hindus should be encouraged to maintain *goshalas* where these animals could be kept.

The villagers should be encouraged to castrate the male stock before 18 months of age.

(9) *Increase of staff.*—In practically all provinces the staff appears wholly inadequate to undertake any systematic attempts at improving cattle-breeding and an increase is essential.

14. The fodder question appears to arise in very different degrees of acuteness in various parts of India. In some provinces, such as parts of Bombay, the Central Provinces, the United Provinces and the Punjab, the question turns largely on the maintenance of a sufficient supply to prevent the great loss of cattle in famine years. In other provinces and other parts of the above provinces the danger of anything like a fodder famine is somewhat remote and the problem centres rather round the prevention of waste and the using to the best advantage of the existing material. In irrigated tracts, for instance, there can never be any actual fodder famine though there may be an insufficiency of supplies owing to the crop system in force. In such tracts it is idle to recommend the growing of drought-resisting plants, whereas these may be of great value in dry parts of the country. The problems to be attacked therefore are essentially of a local character and must be worked out from the point of view of particular localities and nothing more than very general recommendations can be made.

The recommendations of the Committee are :—

(1) That investigation should be made in each province of the existing sources of fodder supply and their utilization to the best advantage. Among other possible sources of supply to which attention might be directed are the bye-products of the cotton seed crushing mills. Experiments undertaken at Poona have tended to show that cotton hulls are of considerable value as fodder. It is also suggested that certain grasses at present grown on a limited scale possess high nutritive value.

Among possible methods of utilization of existing supplies further attention might be paid to ensilage and to the cutting and storage of grass for hay. The present methods are not merely wasteful but tend to lower the nutritive value of the hay.

(2) *Encouragement of cultivators to include some fodder crops in their rotation.*—This is essentially a local problem on which no particular recommendations are called for. It appears, however, desirable to consider whether the object in view cannot be furthered by lowering of the canal rates for such crops in irrigated areas.

(3) *Stall-feeding.*—The Committee are of the opinion that no efforts to popularize stall-feeding are necessary. It is being forced on the cultivators in certain tracts by economic conditions and will doubtless be forced on them in a larger measure in the future. It should, however, be pointed out that stall-feeding must as a general rule be more expensive than grazing. As the pressing problem at the present moment is to increase the number of cattle, stall-feeding cannot from this point of view be recommended in substitution of grazing where facilities for the latter are already in existence. Further the Committee would point out that, because in exceptional circumstances and on a limited scale, the sale of grass from forests has proved successful, it cannot be argued that it will prove equally successful in all cases or over wide areas of forests. For instance in parts of the Central Provinces and Berar where the jungles encroach on or are surrounded by highly cultivated cotton tracts, the demand for grass is so keen that it pays to cut the grass and stall feed ; but in most other tracts of the Central Provinces the jungles are more remote so that the cutting and removal of grass from the jungles to the villages for the purposes of stall-feeding appears impracticable. Much of the forest grass too when cut and baled under present conditions is so rank and coarse as to be unpalatable to cattle and possesses a very low nutritive value.

(4) *Storage against famine.*—Experiments should be undertaken as to the best methods of storing hay and various forms of fodder and demonstrations of the methods recommended given. The co-operative societies would probably form most useful agencies for carrying out these methods. The experiments now being undertaken in the Bombay Presidency for shredding and baling *Karbi* appear to offer a possible solution of storing this form of fodder and if ultimately successful the process might be usefully adopted in other tracts subject to famine.

(5) *Prickly Pear.*—The experiments undertaken in the Bombay Presidency go to show that the prickly pear if properly prepared forms a useful food in famine times. It would also be profitable to feed it as part of the ration when fodder is scarce and prices high. Demonstrations might be given in other parts of the country subject to famine where this plant is found.

(6) *The relative food values of Indian cattle-foods.*—The Committee are of the opinion that a systematic investigation of the subject is desirable and should be best undertaken at Pusa, the necessary staff being entertained to carry out the work. In addition investigations should be conducted at the provincial farms to ascertain, by such methods as weight measurements, the relative feeding values of the different grasses grown in the provinces.

FOURTH DAY.

15. The Committee on subjects II and III (Agriculture) consisted of Dr. Butler (Chairman), Dr. Kunjan Pillai, Messrs. Barnes, Birt, Roberts, and Sherrard.

The President requested members to crystallise their proposals and criticisms into definite resolutions.

SUBJECT II.—(AGRICULTURE) PROGRAMMES OF THE IMPERIAL DEPARTMENT OF AGRICULTURE (APPENDIX A, PAGE 55).

The terms of reference as regards subject II were :—

To examine how far the several programmes meet the requirements of the Provinces and of the other Imperial Officers.

16. The Committee on this subject reported as follows :—

The Committee are of opinion that the recommendations of Committee (A) of the Board of 1910, namely that the programmes of Provincial Departments should show in brief the connection between the proposed lines of work and the results obtained in the past, might with advantage be extended to the programmes of the Imperial Department. The programme presented by the Economic Botanist, Bengal, is referred to as a concrete example of the form which is considered suitable.

Programmes of the Agricultural Chemist, Mycologist, Pathological Entomologist, Agricultural Bacteriologist, Agriculturist and Cotton Specialist.

These programmes are approved.

Programme of the Economic Botanist.—It is understood that the subject of Indigo improvement has been taken over by this officer from the Sirseah Research Station, and it should, therefore, be shown in the programme.

Programme of the Entomologist.—It is recommended that the following be inserted at the end of the section "*Other Insect Pests*" :—"The former of these investigations will be carried on in part in the Punjab in collaboration with the local Department."

After reading the report of the Committee, Dr. Butler stated that Dr. Leather was asked in Committee to explain the objects of the experiments on saltpetre manufacture. At first it was hoped the work would be of value agriculturally, in cheapening the supply of saltpetre as a fertiliser: though this object is not likely to be reached, still, as the manufacture is a village industry of some importance and the experiments had taken up a good deal of time, it appeared desirable to bring them to a conclusion.

In the discussion of the report, it was suggested by Mr. Fletcher that the last paragraph should be omitted, as unnecessary, but he did not press for its omission in view of a general opinion expressed that the work was important.

The report was accepted by the Board.

SUBJECT III.—(AGRICULTURE) PROGRAMMES OF WORK OF THE PROVINCIAL AGRICULTURAL DEPARTMENTS AND OF NATIVE STATES' DEPARTMENTS OF AGRICULTURE. (APPENDIX B, PAGE 59).

17. As regards subject III the terms of reference were :—

(*a*) *To consider how far the programmes of the several Provincial and Native States' Departments meet the requirements of the Imperial Officers and of the other Provinces and States.*

(*b*) *To examine and report how far the recommendations of Committee A of the Board of 1910, printed on page 80 of the Proceedings, and passed by the Board, have been followed in drawing up the programmes.*

1. In this connection the Resolution of the Board of Scientific Advice at its 22nd Meeting on the necessity of drawing a distinction between major and minor investigations will be taken into account. This resolution was in the following terms :—

"*Resolved.—To recommend that those departments that so far have not differentiated between the more and the less important investigations claiming attention should, in future, do so and that programmes should distinguish between main and subsidiary lines of investigation accordingly.*"

The following points are also for consideration :—

(*a*) *A proposal by Mr. Milligan that in future the discussion of Progress Reports (to which short programmes, indicating the direction of the continuation of the work in progress and any new work proposed, would naturally be appended) should be substituted for the discussion of programmes.*

NOTE.—*If this proposal is approved the Board is invited to suggest a procedure for the timely circulation of such reports to members. Debate can thus be regulated by prescribing that previous notice be given to the President of any point in these progress reports which members may wish to discuss.*

(*b*) *A proposal by the Director of Agriculture, Bombay, and Mr. Gammie that Reports of Agricultural Stations should be published, annually* in abstract only, *and in the Director's Administration Report : and* in detail *as separate reports for each station, only every 4th or 5th year, when any results or conclusions arrived at during the interval could be dealt with.*

Dr. Butler then read the report of the Committee on subject III—which report, as subsequently amended, is printed on page 21.

With reference to the Bengal Deputy Director's programme, Mr. Blackwood explained that a proposal for a Second Deputy Director of Agriculture for Bengal had already been made by the Bengal Government.

After an animated discussion on the question of the place of economics on Government Farms, in the course of which it appeared that there was a strong opinion that a clear line should be drawn between experimental and demonstration work in this respect, and that there was not, as the President put it, any indication in Mr. Smith's programme that there was any definite experimental work going on, the Board decided to approve the first paragraph of the programme after emendation so as to apply to demonstration farms only and Dr. Butler agreed to make the corresponding necessary alterations in the Committee's report.

Dr. Leather then suggested that the work of demonstration now carried out under the Director in Bengal should be under the Deputy Director. The President referred to a similar difficulty in Assam where, Mr. McSwiney explained, the so-called Agricultural Assistants were as a compromise still under District Officers to the extent that they had to submit their diaries to them. He thought they should be independent of District Officers and that their designation might be changed to that of Agricultural Inspectors.

Dr. Mann proposed that the opinion expressed by the Committee on subject IV, in paragraph 20 of their report, should be endorsed by the Board, and emphasised the danger of the Agricultural Department being asked merely to suggest work for uncontrolled experimenters.

Dr. Coleman supported this proposal, having been troubled with exactly such cases in Mysore.

Mr. Fletcher demurred to the term " Deputies " (in paragraph 20 mentioned above) as implying Deputy Directors who would thus be placed in control of work that should be under specialists. This led to a discussion as to the advisability of making any recommendation as to the delimitation of work as between the Director of Agriculture and his expert staff. Mr. Clayton, Dr. Butler and many others supported Dr. Mann's proposal as widened by Mr. Fletcher, while Dr. Leather's original proposal was supported by Mr. Wood.

Dr. Mann proposed **a resolution** as follows :—

" That the Board place on record their opinion that if the most effective work is to be done, all subordinate agricultural officers, whatever their rank, should be directly under the Director of Agriculture and his superior staff ; and that while a very close co-operation with the executive head of the district is desirable the actual control should be with the Agricultural Department." This was put to the vote and **adopted** by a majority. RE[illegible]

18. *Mr. Heycock said the paragraph referring to* Bihar *and* Orissa in the Commitee's report was not applicable. The only farm proposed was one at Ranchi, to supervise which a Third Deputy Director had been applied for, it being proposed to train a subordinate staff on the farm. In view of the fact that the departments in Bengal and Bihar had been hampered for want of staff, Dr. Mann proposed a **resolution that :—**

IV. **"The Board consider that, in any Province, the policy of opening farms before there is an adequate superior staff to manage them and that of extending demonstrations before there is a *trained* staff to carry them out, is fundamentally unsound."**

Mr. Heycock seconded this resolution which **was carried unanimously.**

As regards the United Provinces, Mr. Hailey explained that the Deputy Director and Economic Botanist whose programmes were commented on in the first paragraph, had been on leave and the programmes had been written up by their Assistants.

In connection with the Committee's recommendation as to the writing up of the results of experiments on the Cawnpore Farm, Mr. Hailey assured Dr. Leather that Mr. Burt would write up the results as soon as possible. He went on to say that the fourth paragraph of this section of the report showed an entire misapprehension of the position on the part of the Committee. He thought it reflected on Mr. Clarke's work and should be eliminated. Mr. Clarke's work had originated on a farm under an Assistant Director, where there were no laboratory facilities—to the great inconvenience of both officers, and it was agreed by all the officers concerned that Mr. Clarke should have a station of his own, particularly in view of the approaching extension of the work in connection with Dr. Barber's seedlings. Mr. Hailey on the advice of his expert staff had recommended the considerable expenditure necessary and did not think the Board was in a position to question the necessity. Dr. Parr amplified Mr. Hailey's statement laying stress on the fact that the proposal for a separate station was a case of co-operation to secure greater efficiency. Dr. Barber supported this point of view from his experience and said it was almost necessary for a man to grow under his own control, a crop on which he was specialising.

Dr. Butler having explained that it was the words "Agricultural Station" which had misled the Committee, agreed to the deletion of the paragraph.

With reference to the paragraph relating to the Central Provinces, Dr. Butler accepted an alteration proposed by Mr. Allan. The first part of the paragraph then reads: "The Committee notes that there is little reference to experimental work in the programme of the Deputy Director, Northern Circle, and considers that there should be more reference in greater detail to the experimental work in progress."

He explained that the Committee wished to emphasise the desirability of maintaining the improvement already visible in programmes, in the direction of showing the continuity of future with current and past work, and in view of which improvement they had recommended the continuation of the present procedure as regards Programmes.

Dr. Butler also accepted a suggestion that the reference to the omission of any mention of teaching in the Punjab programme should be deleted in favour of a paragraph of more general application which has been added to the Committee's report.

Mr. Ram Gopal agreed to omit from future programmes references to duties such as the maintenance of Government Gardens which were only incidental to his office.

Mr. Milligan, in view of the recent improvement in the form of programmes submitted, withdrew his suggestion as to the discussion of progress reports.

As regards the question of reports of Agricultural Stations, Mr. Smart asked the Board to recommend that they should be dispensed with in Bombay, pending the next meeting of the Board, but the feeling being clearly against this suggestion, it was withdrawn and **the Board adopted the** Committee's **report as amended below.**

19. The Committee first considered the details of the several programmes submitted.

1. *Bengal.*—The Committee notes that there are at present seven farms under the control of the Deputy Director and that it is proposed to add an eighth next year. It is suggested that this is too heavy a charge for a single officer and that either (1) an additional Deputy Director be recruited, or (2) the opening of the new farm be postponed until some of the existing farms can be closed.

With regard to the opening paragraph of the Deputy Director's programme, the Committee wishes to draw attention to the fact that an Experimental Farm should be worked for the purpose of elucidating information, and that ordinarily it cannot be expected to show a profit. This does not apply to Demonstration Farms.

2. *Bihar and Orissa.*—With reference to the first paragraph of the Deputy Director's programme, the committee considers that the policy of opening farms before there is a trained staff to manage them is fundamentally unsound.

3. *United Provinces.*—In the absence of a sufficiently detailed account of the work in progress or projected, the Committee is unable to offer any comments on the programmes of the Deputy Director, Western Circle, and of the Economic Botanist.

It is suggested that it might be of interest to write up the results of the recently discontinued permanent and manurial experiments on the Cawnpur Farm, for departmental publication.

The Committee is of opinion that the Assistant Director, Eastern Circle, is attempting too much, and that it would be better to concentrate on a few important crops or problems.

[Punjab.-/] 4. It is recommended that pure line, intra-varietal selection of wheat might be included in the programme of work of the Economic Botanist if not already in progress. Also that item 8 be deleted from this programme.

5. *Bombay.*—The programme of Bombay is approved.

6. *Madras.*—The programme of Madras is approved.

7. *Central Provinces and Berar.*—The Committee notes that there is little reference to experimental work in the programme of the Deputy Director, Northern Circle, and considers that there should be more reference in greater detail to the experimental work in progress.

It is observed with considerable disappointment that absence of suitable laboratory accommodation continues to hamper the work of the Economic Botanist and the Agricultural Chemist.

8. *Assam.*—The programme of Assam is approved.

9. *Burma.*—The Committee is of opinion that the programmes of the Deputy Director, Northern Circle, the Assistant Botanist, and the Assistant Entomologist do not give sufficient details of the objects and lines of work for adequate scrutiny.

10. *North-West Frontier Province.*—The programme of the North-West Frontier Province is approved.

11. *Mysore.*—The programme of Mysore is approved.

12. *Kashmir.*—The Committee is of opinion that the Kashmir programme is greatly in excess of the capacity of the small staff to execute, and recommends its curtailment in the event of further staff not becoming available. At the same time it is suggested that the importance of Agriculture in this State is such as to warrant liberal expansion of the department.

13. *Travancore.*—The Committee believes that the expansion of work in certain directions is hampered by want of staff and is of opinion that the addition of a botanical and a mycological assistant would enable work of considerable importance in connection with paddy improvement and coconut disease to be taken up.

14. *Baroda.*—The programme of Baroda is approved.

The Committee observes that no note is made of education in some of the programmes submitted and suggests that where the officers of a department are engaged in teaching this should be indicated either in the Director's summary or in the Specialists' programmes.

20. The Committee then examined the form of the programmes, in view of the recommendations of Committee (A) of the Board of 1910 and of the 22nd Meeting of the Board of Scientific Advice, and considers that, with certain exception noted below, these recommendations have been followed, with the result that the Committee's labours have been lightened and a more satisfactory examination of the programmes secured.

In the programmes of the United Provinces, the Northern Circle of the Central Provinces and of Mysore, Travancore and Baroda no sufficient distinction has been drawn between main and subsidiary lines of investigation.

In some of the United Provinces' programmes new work is not indicated and information as to the scope or aim of the work in progress, the results, if any, obtained since the submission of the previous programme, and the direction in which it is proposed to continue during the coming year, is wanting.

In a few cases (Punjab, Burma) the name of the officer responsible for drawing up the programme is omitted. The Committee is of opinion that all programmes should be signed.

The Committee next considered the proposal that in future the discussion of Progress Reports (to which short programmes, indicating the direction of the continuation of the work in progress and any new work proposed, would naturally be appended) should be substituted for the discussion of programmes.

It was decided to recommend that the present procedure should be maintained, provided that the suggestions of Committee (A) of the Board of 1910 be followed, as they have been in the great majority of the programmes under consideration this year.

Finally the Committee considered the proposal that Reports of Agricultural Stations should be published annually, *in abstract only*, and in the Director's Administration Report: and *in detail* as separate reports for each station, only every 4th or 5th year, when any results or conclusions arrived at during the interval could be dealt with.

The Committee is of opinion that this opens up the much larger questions of the standardisation of Farm Reports and the best method of rendering the information contained in them readily available to those interested. The majority of the members are in favour of maintaining annual reports, but it is felt that some steps should be taken to abstract and index their contents, so that other workers would be in a position to find required information on specific points with a minimum amount of labour.

It is suggested that this is a suitable subject for discussion at the next meeting of the Board, and accordingly no definite recommendations are made at present.

SUBJECT IV.—THE BEST MEANS OF BRINGING IMPROVED METHODS OF AGRICULTURE TO THE NOTICE OF CULTIVATORS.

21. The Committee consisted of Dr. Mann (Chairman), Dr. Coleman, Dewan Bahadur Swamikannu Pillai, Rao Bahadur Dharmaranga Razu Garu, Messrs. Chadwick, Clayton, Clouston, Evans and Smart.

The terms of reference were :—

(*a*) *To bring the Report up to date.*

(*b*) *To make recommendations as to the relation that should exist between the subordinate District Agricultural Officers, and the administrative District Officers.*

NOTE.—*In connection with this subject, the inter-relation of the Agricultural and Co-operative Credit Departments can be discussed.*

In introducing the report of the Committee (printed on page 23 below), Dr. Mann acknowledged the assistance received from Mr. Drieberg and Mr. Gonehalli. He pointed out that the report dealt largely with the help that could now be given by Co-operative Societies, owing to the removal by the Act of 1912 of limitations on their activities. This was important owing to the advantage of dealing with organised groups of cultivators, such as the Credit Societies in the United Provinces, and Agricultural Unions in the Central Provinces. In this connection, Dr. Mann explained the importance of paragraphs 3, 6, 7 and 9 of the report. He explained that success in the cases referred to had been based on the superiority of the seed of which the supply was organised by these societies, and recalled references in previous years to the impossibility of pushing any improvement involving outlay of capital, that was not markedly profitable. Manure Societies in Bombay had shown a profit of 25 per cent. He also referred to the very successful Dairy Societies described in paragraph 12 of the report, but suggested the need of consulting local Registrars before expanding on these lines.

In connection with Agricultural Associations, Dr. Mann drew attention to their tendency to divide for the purpose of concentration in smaller tracts.

Coming to local demonstrations by the Agricultural Department, he mentioned the success of the spraying operations against *Koleroga* in Mysore, Madras and Bombay and against mildew on grapes in Bombay.

He referred shortly to the success of Vernacular Journals when published under first rate supervision, and to the value of educational work like that in connection with school gardens in Ceylon, a note on which the Committee recommended that Mr. Drieberg should be asked to append to their report.

At the conclusion of Dr. Mann's remarks, Mr. Chadwick gave particulars of what Co-operative Societies had done in the way of obtaining manures in Madras. The report gave perhaps an exaggerated impression.

In reply to Mr. Ram Gopal, Mr. Clouston said four cows had been lost from Rinderpest in the Central Provinces Dairy Societies last year.

Mr. Burns proposed **a resolution that " in view of the valuable results achieved from experiments on the lands of private gentlemen and in view of the help given by these gentlemen in making known such results, the Board records its appreciation of the assistance given to the Department by educated land-owners."** RESC

He said he had found landholders useful whether agriculturists or not. Mr. Pillai seconded the resolution. In view of the importance of such assistance in experiment and demonstration, in the absence of Co-operative Societies, local experiments were necessary, preferably on private lands, to establish the value of improvements before general demonstration.

The President welcomed assistance from any agency and the resolution **was adopted by the Board.**

Mr. Chadwick proposed **a resolution that " where Registrars of Co-operative Societies are independent of the Directors of Agriculture, the Board wish to emphasise the importance of the closest working between the two Departments in the formation and development of Co-operative Societies designed to undertake agricultural work."** RES

He explained that conditions were very diverse and said that real co-operation based on close intercourse with societies was essential and not casual intercourse and suggestions as to work. The resolution was seconded by Mr. Clayton who agreed absolutely with the proposer, and **was** strongly supported by the Chairman, and **passed unanimously.**

Dr. Parr mentioned that Mr. Leake and he had tried to interest large seed firms, like Messrs. Sutton and Messrs. Garton, in the possibilities of the seed business in India, and he hoped representatives of some of these firms might be sent out. If they were encouraged by Government and succeeded in establishing business on a competitive basis the Department's work would be greatly lightened.

The President emphasised the usefulness of this periodical report from several points of view.

The Board accepted the report as follows :—

22. (1) On three former occasions a committee of the Board of Agriculture has reported on the methods which have proved successful in the hands of the Agricultural Department in bringing agricultural improvements to the notice of, and into the practice of, cultivators. The present report is an attempt to bring the information these reports contained up-to-date, by indicating new methods introduced during the last two years which have been successful or which promise success.

Co-operative Societies.

(2) And undoubtedly the most striking advances during this time have taken place in connection with the development of the co-operative movement. In 1912, the Act was passed which removed the limitation preventing Co-operative Credit Societies doing anything but supply funds to their members, and which allowed the formation of societies with other profitable objects in view. This has resulted in the immediate utilisation of Co-operative Societies for the dissemination of agricultural improvement, and in many cases, with promise of very great success.

(3) In this connection the Committee wish to emphasise the fact that it is desirable that an Agricultural Department should work, if possible, through organised bodies of cultivators, and that one of the most suitable methods of organisation for its purposes is that of Co-operative Societies.

(4) Even without going beyond the old function of societies—that of supplying credit—Co-operative Societies had been used and are still being used for spreading improvements. They have often been used to spread literature and are one of the most effective agencies in doing so. They have in some cases, as for instance in Eastern Bengal, taken the advice of the Agricultural Departments with regard to advancing money for improvements or so-called improvements to be made by their members. And if the Agricultural Departments get into close touch with these societies, the latter will, more and more frequently, appeal to the Departments for guidance in making advances. And thus many promising schemes can be encouraged and many fantastic ideas which will surely arise if money is available, can be checkmated at the first onset.

(5) These things could be done without any extension of their old powers, but as soon as it became possible for the Co-operative Credit Societies to extend their functions they began to do so in many cases under the guidance of the *Agricultural Departments*.

One of the first signs of this was the wish on the part of a number of rural societies to carry a stock of implements and sometimes of seed for sale or hire to their members. This has been done in a number of Provinces, and has often proved a very great convenience besides being profitable to the societies themselves. The stocking of implements and spare parts is easy: that of the seed is more difficult, and a good deal of care must be exercised in recommending ordinary credit societies to undertake it.

(6) The greatest development of miscellaneous agricultural functions has perhaps been reached in the case of some societies in the United Provinces. There, as was referred to in the last report, the relation between the Department and certain societies is very close, and one or two cases may be given as illustration of what is being done and the difficulties which have arisen. In the case of the Gauria Kalan Society, the society takes the seed recommended by the Deputy Director; it practically monopolises the services of an Inspector of the Department; it has a well-borer from the Department in its service while the Deputy Director makes, where necessary, arrangements for marketing the produce of the society to ensure better prices. This society now also runs its own Agricultural Exhibition, and maintains a depôt of implements for sale. The same intimate relations are now being established in other cases. Individual members of those societies already put down and test the value of types of crops recommended and carry out the methods of cultivation taught, but the fullest use, the Director considers, can obviously not be made of them unless as units they will undertake such steps as that of keeping up a supply of the seed given for demonstration. This question of seed is considered to be perhaps the most urgently needed extension of their functions; and it is desired to make them independent and self-contained in the matter of supply of seed to their members. In entering upon it certain practical difficulties have arisen. To carry the arrangements into effect a certain amount of capital is necessary to purchase back seed from the members selected to sow: storehouses are required in which to store it: if the crop is cotton a small ginning factory is desirable, and some staff must be maintained. In other words, these societies, hitherto entirely credit organisations, must enlarge their functions and definitely recognise agricultural improvement as a duty towards the members. A certain amount of reluctance exists among credit societies to make this extension of their functions, and it is a question on which a considerable difference of opinion exists in the Committee as to whether they should be encouraged to do so, or whether special societies or unions should be formed side by side with the credit organisation to undertake these trading functions.

(7) *As an example of the establishment of parallel co-operative societies financially dependent* on the Co-operative Banks but independent in other ways, the development of Agricultural Unions chiefly for seed supply in the northern part of the Central Provinces may be referred to. A full description will be found in a paper on "The Organisation of Seed Farms in the *Central Provinces" by Mr. G. Evans in the Agricultural Journal of India for July, 1913.* The question here has chiefly been that of seed supply and the close connection with the credit societies is seen by the fact that the "Seed Supply Ltd.," Sehora, now has its office at the Central Bank, Sehora, and employs a trained man who supervises the seed farms of its members *besides demonstrating new methods and implements, and maintaining a stock of implements* and spare parts for sale to its members.

(8) In various forms modified to suit local conditions, co-operative organisations for the production and supply of seed will probably be the first results in many rural tracts of the success of credit societies. The details of organisation will vary much, but whether undertaken by the credit societies, or by unions of credit societies (as in Burma), or by separate societies altogether, it forms a probable first step in many cases to very large development in these directions.

(9) An illustration of such seed-producing societies growing independent of previously existing credit organisations, may be given from experience in the cotton tracts of Berar. In this case, they are in the form of Agricultural Unions, which maintain a central seed farm for the production of cotton seed, and provide ginning machinery for ginning the seed of *rosea* cotton from a number of branch farms run by the members. The capital is used in running the central farm, and the supply of the necessary gins, and the seed from which they work on the central farm is obtained annually from the Agricultural Department. The financial result has hitherto been satisfactory, and the extension of such unions will bring about the transfer from the Agricultural Department of the spreading of the improved forms of cotton seed suitable to the district.

(10) In no other direction has development gone so far as in co-operation for the production and distribution of seed, but a certain amount of experience has been already gained in the formation of societies for the purchase and distribution of concentrated manures in Bombay, and for dairy purposes in the Central Provinces and the United Provinces.

(11) In the case of manure societies, a notable success has been achieved at Kelva Mahim near Bombay where in a tract of very intensive culture, with a large demand for castor cake, the first year's operations, on the basis of a co-operative capital of Rs. 7,500, a profit of 25 per cent. has been secured and the cake sold below the market rate. It has secured also that the market rate has been much lower than it would have otherwise been. In this case, the co-operators were almost exclusively the gardeners themselves, but the management was in the hands of a keen local man, not however a gardener. A larger manure supply society has recently been promoted in one of the sugarcane tracts in the Deccan, with a capital of Rs. 20,000. It has *succeeded in coming out soundly from the first year's trading*, though there will be no large actual profit, but it has caused the price of fish-manure (in which it dealt) not to rise as was invariably the case in former years. The result of its experience is to indicate that such a society is best run when the shareholders are Co-operative Credit *Societies who can buy for the benefit of their members rather than individual cultivators.*

(12) As regards dairy societies, the experiment at Nagpur, organised by the Central Provinces Agricultural Department is a very interesting one, which has now been working 13 months.

A capital of Rs. 30,000 was laid down by Government, Rs. 20,000 to purchase land and Rs. 10,000 to put up sheds, and the co-operating *Gaolies* put their cattle on this land and in these sheds. They pay Rs. 6 for pasturage of a milking cow, and Rs. 3 for a dry cow or young stock per annum, and purchase other food from the Government, who buy in bulk and hence at a low rate. The cattle are milked before a special staff retained and paid by the Department and the milk is sold at 8 seers per rupee for buffalo's milk and 8½ seers per rupee for cow's milk to a contractor who retails it at 6 seers per rupee. At present, there are 320 animals in the scheme and it appears to have paid all concerned, while more *Gaolies* are gradually coming into the society and bringing their animals.

Another somewhat similar scheme, though one quite independent of Government and of the Agricultural Department, has been worked in the neighbourhood of Benares, and there seems a good deal of scope for encouraging co-operation in the improvement of dairy conditions.

In the Central Provinces one co-operative cattle-breeding society has been started in the Raipur district, and a second one will be registered very shortly. The former society leased 400 acres of grazing land from Government, and commenced with a herd of forty cows and one bull, purchased for them by the Agricultural Department. The members themselves in their villages had no cows good enough to use as the foundation of a breeding herd. The share capital is Rs. 3,000; the shares are Rs. 100 each. Each member is allowed to have up to six cows on the farm. The cows are branded and remain the member's own property, while the bull belongs to the Society. The portion of the working expenses debited against each member is proportionate to the number of cows he keeps, the rate for grazing, food-stuffs, the service of the bull, and supervision being fixed at so much per head of stock.

(13) On the whole, enough has been done in these various directions to indicate how in many ways Co-operative Societies may be used or encouraged or established to bring agricultural improvements into use. It must be emphasised, however, that a Co-operative Society is a business concern, and cannot undertake agricultural propaganda for its own sake. Caution should probably even be exercised in recommending them to do anything which will not actually be productive to the society as a society, even where it may be profitable to the members individually, and in these doubtful cases, probably careful consultation with the local Registrar of Co-operative Credit Societies, should precede any recommendation or even approval of action by a society which does not lead to profit to itself as a co-operative body.

Agricultural Associations.

(14) There is not much to be said regarding the other methods referred to in previous reports except to note tendencies in development and lines of progress. As regards Agricultural Associations, it may be noted for instance in the Central Provinces that District Agricultural Associations in some districts are tending to form branches, the Association itself only meeting once a year at the time of the annual show, a show being held in each district each year. This is a result of several distinct tracts being included in one district. Each local branch is presided over by a member of the District Agricultural Association. The tendency for the same men to be the leaders in the Agricultural Associations and in Co-operative Organisations is very marked in this province.

In Bombay, the tendency is to try and bring the Agricultural Associations into closer touch with the Department and its officers, and to refuse to recognise any which do not conform in their working to a system laid down by the Agricultural Department.

Local Demonstrations.

(15) In Bombay and elsewhere, the local demonstrations on the Department's farms are being now organised on a much more extended scale than hitherto, and in close co-operation with the Revenue Department. In the present year, the College Farm was the scene for practically every day for a month of the visits of groups of cultivators for each taluka led by the Mamlatdar to the Farm, and a special Agricultural Overseer of the best type was put on for the whole of the time to demonstrate and entertain the people. This will probably be done even more widely in the coming year.

The success of the operations against *Koleroga*, the disease of the betelnut palm, in Mysore and Madras, is worthy of notice. Sprayers and spraying materials were sent down with competent men to the affected tracts. In some cases opposition was encountered at first, but ultimately a very large number of trees were sprayed and very good results have followed. In Mysore at least 200 acres of betel-palm were sprayed, one hundred acres of which were sprayed by the garden owners themselves, and 70 sprayers were sold. There may be a demand for 50 more sprayers next year. In Madras, 13,520 trees were sprayed and the people have done 1,300 more on their own initiative. The success of the work in Mysore seems to be due to the fact that the Department refused to sell sprayers till the operations were a proved success, that local men were used to carry out the work, and that the garden owners were persuaded to bear a large part of the cost themselves.

An interesting case of the utilisation of school children in work is recorded from Mysore, where they were used to collect moths of hairy caterpillars—one of the worst pests—on emergence. No less than 20,000 moths were collected by the children, and it has been so effective that it is proposed to use it in other cases.

Other local demonstration methods, many of which have been very successful, seem to be largely, if not entirely, developments of methods already described.

Vernacular Literature.

(16) In two cases at least where Agricultural Journals in vernacular are published, the Agricultural Journal has established a co-operative section during the last period. When well run the journals obtain a large circulation and are in every way a success. In other provinces, both agricultural and co-operative matter is freely taken by the Vernacular press. The leading vernacular paper in Mandalay (Burma) publishes a Co-operative Supplement once a month which all societies take, and special pages are set aside by the two leading papers in Mysore for agricultural matter supplied by the Agricultural Department. This use of the local

press is in every way to be encouraged, and the best of the Indian staff should be urged to contribute.

Educational Courses.

(17) Short courses in special subjects on the various farms have been developed in a number of provinces especially in the Central Provinces, but they present no new features. The Vernacular Agricultural School of Bombay described in the last report has been copied in Baroda and perhaps may be commended for consideration elsewhere.

(18) Mr. Drieberg, Director of School Gardens in Ceylon, gave the Committee an account of what has been done in this direction in Ceylon, and the Committee recommend that he should be asked to record a note on the subject as an appendix to this report. A first effort to establish school gardens in Burma has aroused great keenness, and the parents have co-operated extensively in making such gardens a success.

Itinerant Assistants.

(19) The success of itinerant assistants in some directions in Madras has been surprising and is worthy of record. They were sent into villages to instruct the people in the transplantation of single seedlings in paddy cultivation, and in encouraging the green-manuring of paddy lands. In the latter. no less than 150,000 lbs. of green-manure seed were sold ; as a result depôts were established in villages and the people are now supplied in the ordinary conrse of trade.

Position of District Agricultural Officers.

(20) The Committee consider it advisable to place on record their opinion that if the most effective work is to be done, all subordinate agricultural officers, whatever their rank, should be directly under the control of the Director of Agriculture and his superior staff. While a very close co-operation with the executive head of the district is desirable, the actual control should be with the Agricultural Department.

Conclusion.

(21) In conclusion, the Committee feel that much progress has been made during the last two years in the adaptation of methods to local conditions, and in the introduction of co-operative organisations as means of doing the work of bringing improvements into the practice of cultivators. They would again insist on the necessity of concentration, both with regard to areas and subjects, to what can be well covered with the staff available, and the equal need of the close correlation between farm and research work and the practice of the cultivators. If this close correlation is secured, the work for which the Departments exist, namely, the improvement of actual agricultural practice in this country, will be most quickly and most effectively secured.

APPENDIX TO THE REPORT OF COMMITTEE ON SUBJECT IV.

NOTE ON SCHOOL GARDENS IN CEYLON.

(C. Drieberg, B.A., F.H.A.S., Secretary, Ceylon Agricultural Society.)

The following note will give an idea of what we have done in Ceylon for the sons of cultivators with a view to better equip them for their future life, and the lines upon which the work so begun is developing.

About 10 years ago it was decided to adopt a scheme for establishing gardens in connection with Government vernacular schools in order to give a practical side to the ordinary school curriculum.

A start was made with a selection of half a dozen schools provided with facilities for gardening, *viz.*, a suitable piece of land and a satisfactory water supply.

Beginning in this small way the scheme gradually developed till to-day we have 250 school gardens distributed throughout the island.

The scheme may be briefly described as follows :—

About an acre of the land attached to the school is set apart for the garden. Where no crown land is available the District School Committee (of which the chief Revenue Officer is Chairman) provides the required area by purchase or long lease, meeting the cost from a local fund.

The cost of wire for fencing (say Rs. 25) and of garden implements (say another Rs. 25) is met from the vote for school gardens allowed by Government, but the cost of erecting the fence and where necessary of providing a water supply is borne by the local authorities.

The gardens are controlled by a superintendent with the assistance of three inspectors (each of whom is in charge of a third of the island) who are constantly on tour, keeping the work going on proper lines.

The garden itself is generally divided into three sections—an ornamental section in front of the school, an economic section consisting chiefly of vegetable plots occupying the two sides and a fruit section in the back ground.

The necessary seeds and plants are mainly supplied from a stock garden in Colombo where it is sought to exemplify all that is expected of a school garden and where new products are first tried before being sent out.

The actual work of the school garden is done by the school children and no paid labour is allowed. This work is generally done in the early morning before the regular school work begins : the garden being divided up among the different standards and the children working under the supervision of the teacher, his assistants and monitors.

At first two difficulties were encountered: the prejudice of parents against their children engaging in manual labour and the inexperience of teachers.

The former soon gave way before the spontaneous interest which the children displayed in the outdoor work and the healthy competition which sprang up between different classes and between one school and another. The latter difficulty was minimised by the practical instruction imparted by the trained men who visited the gardens.

A course of nature study and elementary science combined with practical outdoor work was subsequently made part of the curriculum of the teachers under training so that now teachers are better qualified for their duties under the new order of things.

A further development is about to take place by providing a short special course of agricultural training for teachers after their course in the normal school, while from next year a set of agricultural readers will be introduced into Government vernacular schools. Last year school gardening was included in the government educational code as a subject for grant so that it may be expected that all private schools will take up the movement.

As a result of the operation of the scheme for school gardens the surroundings of our schools are being altered beyond recognition. Originally bare and uninviting, they are now bright and attractive.

The outlook of the village school boy is being widened and his mind given that bent which is appropriate to him as a unit in a rural population; while through his daily experience in the growing and tending of plants he acquires a knowledge of the fundamental principles of agriculture. Incidentally the school garden is a means of introducing new plants—chiefly additions to the food supply—which the children help to disseminate in the villages.

The produce of the garden is shared by the teacher and boys while there is also a vote for prizes for the best gardens—half the award going to the teacher and the other half being distributed among the three best workers.

It will thus be seen that we are taking full advantage of the opportunity of working through village school children (the most promising material) for the benefit of the rural population and I think it will be admitted that the scheme is calculated to better equip these boys for the life before them so that they would enter upon their business with a wider outlook upon the world and with a foundation of technical knowledge upon which to build.

Within the next few years it is intended to establish a number of agricultural schools throughout the island, so that on leaving the ordinary village school the boys may have an opportunity of continuing and so to speak specialising in agriculture. It is for these schools that we are getting four young men trained at the Poona Agricultural College.

Subject VII.—The Indian Sugar Industry.

23. This subject was considered by a committee consisting of Dr. Barber (Chairman), Drs. Leather, Butler and Parr, Messrs. Birt, Clarke, Heycock, Meggitt, and Robertson-Brown.

The terms of reference were :—

The report of the Committee on subject XII at the last Meeting of the Board will be taken as the basis for discussion of the Provincial Reports on the action taken, or progress made, on the lines recommended by the Committee and endorsed by the last Board. Is any further action desirable at this stage?

Dr. Barber read the report of the Committee which, as subsequently amended, is printed on page 28 below.

The discussion was opened by Mr. Barnes who asked with reference to the factory at Pilibhit, what price was paid for the cane, and whether the factory had any control over the cane-growing area. In Egypt only factories with a capitalisation of as much as £ 200,000 had survived and they found it necessary to own and control 20 to 25 per cent. of the necessary cane-growing area in order to steady the market. It was a curious and significant fact that a similar experience had been obtained with beet sugar factories, and the capital required was about the same.

Mr. Hailey explained that the factory at Pilibhit itself owned no land, though the necessity was generally recognised. The conditions were somewhat peculiar as the proprietor had considerable influence and the supply of cane was secured by a system of advances on condition of delivery of cane at a fixed price. So far, there had been no difficulty in getting sufficient cane for a factory in any suitable district. Most factories worked on a similar system.

The real difficulty was to regulate the supply of cane: this year more was offered than could be bought.

Mr. Barnes said the system of control by advances also obtained in Egypt where small factories nevertheless failed.

Mr. Hailey said factories in Bihar paid—of which he understood some were not much larger than that at Pilibhit—and perhaps the distance of Upper India from the sea had a protective effect.

Mr. Barnes suggested that it was premature to say that the Pilibhit factory was a success and Mr. Hailey amended the report, which now read that the factory had had a satisfactory year's working.

In reply to Mr. Barnes, Mr. Brown said sugar beet would yield up to 17 tons per acre at Peshawar and tended to be over-luxuriant.

Mr. Wood asked for fuller information as to the advances mentioned in paragraph (15) of the report.

Mr. McSwiney said that in Assam the Chief Commissioner had decided that any kind of advance for trading purposes was contrary to the Secretary of State's orders.

Mr. Hailey said the advance in the United Provinces was amply secured and was conditional on the factory being used for demonstration and tuition.

Mr. Clayton explained that in Burma, as a result of the report of the expert, a Rangoon firm proposed to conduct an experiment in sugarcane over a period of 18 months in the Môn Canals area under the personal supervision of a Java expert. A sum of Rs. 10,000, approximating to half the total anticipated expenditure, has been promised by the local Government—on certain conditions—towards the cost of the experiment, which will probably be commenced next year.

Dr. Barber agreed to amend the Committee's report accordingly.

As regards the Punjab, Mr. Hamilton asked Dr. Barber to substitute the following statement for that in the report which might mislead those unacquainted with the local conditions :—

"In the Punjab, a scheme has been under consideration for allotting a tract of land in the lands to be colonised on the Lower Bari Doab Canal, under such conditions that if a Central Factory be afterwards established the tenants can be required to put a large area under cane and forbidden to sell it for sugar making except to the factory. The tract is not, however, one particularly suited to cane growing."

Dr. Barber agreed to amend the report accordingly.

Mr. Hailey said that if Government really wished to encourage the industry—and this was very necessary in parts of the United Provinces where there was a glut of *gur*,—the best way would be to give central factories a preference in regard to distillery contracts for the manufacture of which *molasses* were now imported from Java.

The establishment of such factories stimulated the improvement of cane by weeding out the inferior classes. Experience had proved this, and it would facilitate the introduction of improved varieties.

Mr. Barnes confirmed Mr. Hailey's experience as regards the importation of *molasses* and instanced two distilleries which bought them from Java owing to the duty on imported spirit. There was no doubt that a factory did not produce enough *molasses* to keep a distillery going, and *gur* was even brought into the Punjab from the United Provinces for distillery purposes.

Mr. Hailey could not confirm this experience as regards the United Provinces.

The amended report was unanimously approved as given below :—

24. The Committee on the Indian Sugar Industry present the following report. For the sake of convenience of reference the headings of report of the Committee on this subject in 1911 have been followed throughout. Analysis of the action taken or progress made on the lines recommended is appended together with such remarks and recommendations as the Committee have thought it necessary to make. *The Committee note with satisfaction the progress made in many directions, considering the short period which has elapsed since the last Board's Proceedings have been in the hands of Local Governments, and do not consider it necessary to advocate any further action than that suggested in their remarks on*

(1), (2), and (3)—No remarks.

(4) *Mechanical Aspect.*—(Manufacture.) The Board's recommendation that a Sugar Engineer should be entertained has been carried into effect. Mr. Hulme was selected for the post and has been attached to the Agricultural Department in the United Provinces. He has paid a considerable amount of attention to the aided factory at Pilibhit capable of dealing with 100 tons of cane per day. This factory has been completely remodelled under his direction, and has had a satisfactory year's working. He has given technical advice regarding the starting of two factories in the Gorakhpur District one of which is being constructed. He also supervised the working of the small plant model factory brought out for the Allahabad Exhibition (which proved a failure owing to its small size). He has examined into several schemes for starting central factories and prepared projects. Most valuable work has been done by Mr. Hulme in investigating the most suitable plant for working the fibrous canes of Upper India and for the production of a sugar, so closely resembling that made by the indigenous methods as to command the same artificial price. In connection with the consideration of the projects for establishing central factories the Director has nearly completed a most valuable enquiry regarding the cost of producing cane in various tracts. Lastly Mr. Hulme has given a great deal of attention to the furnishing of better and cheaper crushing plant and a more economical boiling process for the manufacture of *gul.* In these enquiries, however, he has been much hampered by the prevailing scarcity of the present season.

The Committee note with satisfaction that Mr. Hulme has been reappointed for a further term of two years.

The Departments of Assam and the Central Provinces report that iron mills are being pushed to replace the older wooden ones in the less accessible parts of their districts. Various experiments are detailed by Bombay, including some on improved furnaces and more economical crushing mills.

(5) *Agricultural Aspect.*—(*a*) Surveying and testing varieties under chemical control and (*b*) testing such imported varieties as appear suitable.

United Provinces.—A farm has been opened at Nawabganj near Bareilly under Dr. Parr largely for the collection and growth of the canes of the tract and their comparison with imported varieties. Another farm has been founded at Shahjahanpur for the more detailed chemical investigation of the local and introduced canes, and this has been placed under the Agricultural Chemist, Mr. Clarke.

A new circle is about to be opened, with Gorakhpur as headquarters, chiefly in connection with sugarcane work, and a farm is being opened at the latter place which will largely deal with sugarcane in conjunction with the factories being established there.

Bihar and Orissa.—In accordance with the Resolution passed by the last meeting of the Board that a sugar station should be opened in Bihar, north of the Ganges, a combined cattle and sugarcane farm has been started at Sipaya in the Saran District. It is not clear to the Committee how the Sipaya Farm, established for combined cattle-breeding and cane work, can be efficiently worked by the staff already entertained as this apparently does not provide for continuous scientific control of the cane work on the spot.

The Committee recognises the importance of the work done by Messrs. Taylor and Woodhouse on sugarcane at Sabour and trusts that the investigations by Mr. Taylor on the quantity and quality of the fibre and the mode of ripening will be continued.

Assam.—Work has been continued and extended at Jorhat and interesting results in the growth of thick canes have been obtained. This is especially important because of the proposed opening up of tracts in the Kamrup District.

Punjab.—A chemical survey of the canes at Gurdaspur has been made by the Provincial Agricultural Chemist; a survey has been completed by the Deputy Director of the two districts, Gurdaspur and Hoshiarpur, and this work is being extended to other districts.

A considerable amount of work is being carried out in less important sugarcane tracts. The Central Provinces report considerable activity in surveying the local canes. In Bombay a survey has been made of the occurrence of red rot in the presidency.

Bengal.—The Committee considers that the recommendations of the Board have not been carried out in Bengal possibly for want of staff. They desire to call attention to this because of the fact that the area under sugarcane in this province amounts to nearly a quarter of a million acres. It is hoped that early steps may be taken to give effect to the Board's recommendations.

(*c*) *Facilitating the distribution of the best kinds.*—The Committee presumes that this is taking place wherever an improved kind has been obtained and notes especially the statements made regarding work of this kind in Assam, Central Proivinces, Bombay, Madras and the United Provinces.

(*d*) *Demonstration of Improved Mechanical Methods.* ( ) *Study of Tillage, Manuring, Watering and Drainage.*—It is presumed that this will form part of the work of the newly-opened farms although no special mention is made of it. Among the minor references to the subject the introduction of oil-cakes as a cane manure into the Central Provinces and the value of burying the trash for the Poona soils appear to be the most significant.

(6) *Botanical aspect.*—With reference to the recommendation of the Board that a cane-breeding station should be opened in Madras under an Imperial Officer, such a station has been opened at Coimbatore under Dr. Barber but he has been retained as an officer of the Madras Department of Agriculture with headquarters at Coimbatore. A separate note deals with this farm, the details of progress having been brought up to the date of the Committee's meeting.

(7), (8), and (9)—No remarks.

(10) *Other sources of sugar.*—Mr. Annett has done a considerable amount of work in connection with the Palm Sugar Industry. The results of his study thus far obtained have been published and work on the subject is being continued.

Sugar Beet at Peshawar.—The following statement is recorded regarding sugar beet in Peshawar. The Committee consider that this interesting work by Mr. Robertson-Brown and Dr. Leather is being conducted on right lines :—

"The experiments on sugar beet at Peshawar have shown that this crop will grow and ripen to great perfection. The current year's experiments are intended to show over what length of season the crop will ripen. If these experiments show that there is a prospect of the season extending over three months, the next stage will be to ask a number of zamindars to grow the crop in order to ascertain whether they can do this readily and at what cost. Also it is to be realised that this crop is of no use except for sugar manufacture in a factory and that such a factory will not be built until capitalists can actually see a reasonable area under the crop. A number of zamindars have agreed to grow small experimental fields of sugar beet and it is expected that thirty acres of roots will be grown in Peshawar District in 1914. The North-West Frontier Province Administration will purchase these roots."

(11) and (12) No remarks.

(13) *Area of Extension* : (14) *Land Acquisition* : (16) *Land Grants.*

Punjab.—In the Punjab, a scheme has been under consideration for allotting a tract of land in the lands to be colonised on the Lower Bari Doab Canal, under such conditions that if a Central factory be afterwards established, the tenants can be required to put a large area under cane and forbidden to sell it for sugar making except to the factory. The tract is not, however, one particularly suited to cane growing.

Assam.—An important piece of work has been done in locating and surveying large areas in the Kamrup District, apparently suitable for sugarcane growing on a large scale. This survey resulted in the discovery of several areas of 10,000 acres, eminently suitable for working with steam tackle. It is proposed to conduct an experiment with steam tackle in 1914-15. Meantime 40 acres of thick canes are to be put down to furnish seed for a larger area and, if successful, these canes are to be shown to capitalists likely to consider the erection of an up-to-date factory dealing with 2,000 acres of cane. It is estimated that there is room for a number of such factories in the tract. While recognising the difficulties still to be surmounted, the Committee trust that the possibilities of this extension in the area under sugarcane will be fully tested, and consider that, if successful, no efforts should be spared to bring it to the notice of capitalists.

Central Provinces.—An option for a sugarcane area needed by a factory commanded by the Ghorajhere tank has been granted by the Local Administration to Mr. J. McGlashan of Cawnpore with a view to the formation of a company. The lease has been drawn up of 4,632 acres of Government waste land untramelled by any rights or obligations of tenants, and clearing operations are in progress. A nursery of canes is being opened at Sindewahi largely for the provision of seed for this area, if a company is formed.

Burma.—A Java Cane Expert has toured through Burma with the idea of founding a factory for a Rangoon firm. He has pointed out that adequate irrigation facilities are of prime importance and considers that the area commanded by the recently opened Môn Canals in the Minbu District of Upper Burma is the only tract which is suitable. The Department of Agriculture agrees with the Cane Expert. As a result of the report of the expert, the Rangoon firm proposes to conduct an experiment in sugarcane over a period of 18 months in this area under the personal supervision of the expert. A sum of Rs. 10,000 approximating to half the total anticipated expenditure, has been promised by the Local Government on certain conditions towards the cost of the experiment, which will probably be commenced next year. Meantime, a small experimental station has been opened in this tract in which special attention will be devoted to sugarcane.

The Agricultural Department has examined Tennaserim and Mergui lands and finds that the total absence of railways and roads places the establishment of a factory there outside the range of practical politics.

United Provinces.—The Committee notes the considerable increase in the area under sugarcane in this tract and trusts that the present unfavourable season will not interfere with extension of areas in these provinces.

(15) *Pecuniary Assistance* (by subsidies, taking deferred shares and in other ways).—Besides the assistance rendered in Burma, Assam, and the Central Provinces in opening small stations and putting down cane nurseries to provide planting materials the following assistance has been offered or given to factories since the last Board's meeting.

United Provinces.—A subsidy has been granted to the Pilibhit factory, subject to certain conditions. One factory in the Gorakhpur District has received an advance. As stated above the services of the Sugar Engineer have been freely placed at the disposal of these enterprises.

Punjab.—The Director of Agriculture proposed a subsidy to the Harikishan Sugar Mill at Amritsar, of Rs. 20,000 provided that certain conditions were fulfilled. This concern was examined carefully by the Punjab Agricultural Chemist and certain defects were pointed out. The Punjab Government have withheld the subsidy until Mr. Barnes' suggestions have been attended to and until the factory is in a sound financial condition.

The Director of Agriculture has also proposed a scheme for the establishment of a co-operative *gur*-making society in Gurdaspur, the centre of the local industry. The cost would be about Rs. 30,000, and he proposed that Government should take shares to the extent of Rs. 10,000 in it. It appears that the price of canes is at present the chief bar to the fulfilment of the scheme.

25. Dr. Barber then read his report of progress on the Cane-breeding Station at Coimbatore.

Progress Report of the Cane-breeding Station at Coimbatore.

The appointment of Sugarcane Expert was made in the end of October 1912. One year has now passed. The land was acquired on April 1st, 1913; the station has been founded and the buildings are up and occupied. It will take some time to get the land into order, as it has been for years past irrigated from a series of alkaline wells and much of it is not in very good physical condition.

Last year's seedlings, planted in the Botanic Garden, have been cut, examined, analysed and replanted: over 2,000 seedlings were selected for growth during the present year, were planted on the new land and are now approaching maturity. Many of them especially with certain parentage, are themselves flowering freely.

Large collections of varieties have been brought down from Northern India and are now growing on the farm. These are intended for detailed morphological study and may provide us with hardy parents to be crossed with richer Southern kinds.

A detailed morphological study of many kinds has been commenced and some steps have been taken towards the classification of *desi* Indian canes. This study is now almost completed with regard to the Punjab canes and it is proposed to publish an account of these early next year in conjunction with studies made by the Agricultural Chemist of the Province. It is hoped, as material accumulates, to deal in a similar manner with the much larger numbers of varieties in the other Provinces.

The study of specific and varietal characters of wild and cultivated Saccharums is being steadily pushed on, but it is a subject of extraordinary difficulty in that it is entirely unbroken ground and the canes appear to vary greatly under different climatic conditions. It is, however, proposed next year to publish some account of those characters already noted, in order to enable workers in the Provinces to study and classify their canes on the spot.

Three long tours were made in North Indian sugarcane tracts while the station was being formed. The greatest help was obtained from those stations where collections of local canes had been made, especially Sabour, Pusa, Aligarh and Gurdaspur. It is hoped that such collections of *desi* canes may be kept intact, wherever they exist, at any rate until they can be visited, as much labour will thus be saved.

With regard to the seedlings which we have thus far raised we have been largely dependent on those canes around Coimbatore which have flowered, together with arrows sent from Bangalore and the Madras farms. Four wild species of *Saccharum* have been established and seedlings obtained from three of these. Crosses have been successfully made between *Saccharum spontaneum* (*kans* grass) and two North Indian *desi* canes. These will be used for the two-fold purpose of tracing the origin of the cultivated forms and determining the fixity of the morphological characters observed. It is hoped thus gradually to clear the way for Mendelian studies, but this subject is at present obscured by uncertainty whether the cultivated forms are pure species or the progeny of crosses.

Note on the Seedling work at the Cane-breeding Station.

The work on seedlings may be divided into four sections :—

(1) To determine whether seedlings can be raised in India.

(2) To exercise efficient control over the character of the seedlings raised. Their value can only be fully determined after chemical analysis, but it can be greatly assisted by obtaining definite crosses between parents of approved value. The points of chief importance are high sucrose content, great vigour and disease resistance.

(3) To distribute selected seedlings to the Provinces, with due regard to their special needs.

(4) To bring those ultimately chosen into general cultivation. (This last will be the work of the Local Departments.)

(1) As shown below, it is obvious that, at Coimbatore cane seedlings can be raised in quantity. There is indeed no reason why a million seedlings may not be obtained in a single season of suitable climatic conditions. The number dealt with will however depend on the staff available. The more it is found possible to grow and to test chemically the greater will be the number of good ones ultimately available. The selection of Coimbatore as a centre is thus fully vindicated. All attempts to raise seedlings in North India have thus far failed, apparently because of the infertility of the anthers.

(2) The control of the parentage is not at present satisfactory. *Selfing* has now been successful in a certain number of cases and is not generally difficult. But hitherto the great majority of suitable arrows have had to be obtained from the fields of cultivators and certain farms where wet land cultivation is in vogue. From local observations, it would seem preferable to plant canes in August to November for free arrowing, instead of the more usual planting in February, and a number of plots have been recently put down with suitable parents in juxtaposition on the farm. At present crosses can only be effected when one parent, the female has infertile stamens. I regard it as quite possible that any two parents can be crossed, but this work is a very difficult and laborious piece of technique which cannot be attempted with the present staff.

(3) The selection of canes suitable for different parts of India is engaging careful attention and some idea has now been formed as to what is required in the different parts of North India. For knowledge to be gained on this point further tours will be necessary, especially to the Central Provinces, Assam, Bengal and Burma.

Summary of Seedlings thus far raised.

1911-12.—Before the appointment of Sugarcane Expert was sanctioned the Government Botanist of Madras made preliminary trials, which resulted in the production of some 32 seedlings which were grown in the Botanic Garden and grown to maturity. These were as follows, there being no certainty as to the male parents.

Cheni (Mysore) 20; *Poovan* 7, *Kaludai Boothan* 2, *Vellai* 1, *Namam* 2 *(Coimbatore)*. Quantities of seedlings of *Saccharum spontaneum* (Coimbatore) and *Saccharum Narenga* (Bihar) were also raised and some of the former were found to contain relatively high sucrose content.

1912-13.—All the seedlings previously obtained were planted on the Cane-breeding Station from cuttings. From 12,000 to 15,000 seedlings were raised during the arrowing season and, of these over 2,000 of the healthiest and most vigorous were selected and planted out on the farm, their parents being as follows :—

(1) Male parents unknown. Chittan 760, Karun 500, Kaludai Boothan 260, Poovan 26 (Coimbatore); Naanal 200 (Karur); Seema-like Mauritius 30 (Samalkota); Java 16 (Mysore); and 1—3 each of Chin, Pattapatti and Boothan.

(2) Both parents known. Saretha selfed 68 (Botanic Garden);

Crosses :—Chin by *Saccharum spontaneum* (male) 17 and Shakarchynia by *Saccharum spontaneum* (male) 83 (Botanic Garden).

1913-14.—The season was unfavourable. Many of the canes flowered early and at a time when there was heavy wind and rain. A trained peon was sent to Mysore to obtain additional arrows from there. About 250 pans have been sown at the time of writing and about half of these have come to the germinating stage. About 5,000 had germinated on the 6th December 1913. These consist of the flowering varieties :—

(1) Male parent doubtful; Karun, Chittan, Kaludai Boothan, Poovan, Vellai, Reddish white (Mysore), B208, Ashy Mauritius, Striped Mauritius, Red Sport from Striped Mauritius, Green sport from Striped Mauritius, B376.

(2) Selfed; Karun, Chittan, Kaludai Boothan, Poovan and Green Sport from Striped Mauritius.

(3) Crosses; Vellai by *Saccharum Narenga*, V. by Ashy Mauritius, V. by Striped Mauritius V. by Chittan; J 36 by B 376; Saretha selfed by Fiji C.

Assistance which can be afforded by Provincial Farms.

(1) As complete collections as possible should be made of all the *desi* canes of the tract represented by any farm. These are wanted for the following reasons. The Sugarcane Expert has decided for the present to concentrate his attention chiefly on indigenous Indian canes, with the idea of ultimately preparing descriptions of them all. They are also wanted for introduction to the Coimbatore Farm on the chance of their arrowing and producing fertile seed there, as several of the North Indian canes have already done. Such hardy, acclimatised canes would form suitable parents to be crossed with richer, less hardy, Southern ones.

(2) Growing alongside these local canes, such others should be introduced as appear likely to be of use in the tract, together with any seedlings distributed from the Cane-breeding Station. It is quite possible that a number of such seedlings may be ready for experimental trial early in 1915, although, from the nature of the case, no promise can be given. Records of their behaviour in different localities will be of great help in determining their value and the type of cane to be aimed at for any particular tract. I would here plead for some discrimination being exercised in the introduction of new kinds to any place. But, when once introduced such kinds should receive a fair trial for it is abundantly evident that it often takes several years for an introduced cane to assume its permanent form under new conditions.

(3) Wherever possible, a scientific study should be made locally of the canes grown. In this I would suggest among other things the chemical analysis of the local canes as compared with those introduced, their mode and rapidity of ripening, the noting of any special character whether botanical, chemical or agricultural, their resistance to any local defect of climate or agricultural practice, and so on. For instance, in choosing parents for seedlings intended for the Punjab, frost resistance would be a matter of some importance and canes showing this character would naturally be chosen to cross with richer, larger canes.

It is quite a mistake to assume that all sugarcane work other than testing seedlings sent out by the Cane-breeding Station should cease in Provincial farms. This local work should rather be increased and concentrated. The range of work of the Sugarcane Expert is far too large to be fully covered during the short term of his appointment and there is not the least danger of overlapping, in any direction, while, on the contrary, any work in any direction will materially aid him in producing successful results.

(4) Special attention should be paid to the arrowing of canes. It would be useful if immediate report by wire were sent regarding the appearance of arrows on any canes or in any of the cultivated fields. If the anthers of these arrows appear to be healthy, others of the same kind should be bagged before opening, on the chance of obtaining seedlings not available elsewhere. It is of great importance to obtain seedlings from as many different parents as possible, in the absence of any real knowledge of the working of Mendelian laws in the sugarcane.

The whole question of arrowing, indeed, besides being of great scientific importance, lies at the heart of the success of the Cane-breeding Station. There are various superstitions as to its cause in different parts of the country extending from waterlogging to drought and the portent of some dire calamity, and the matter is well worth investigating. It would be of great advantage if specially selected parents could be made to arrow at will and desirable characters united in the offspring. In this respect the work of the Sugarcane Expert suffers very greatly in comparison with that of others engaged in plant-breeding.

The President thanked Dr. Barber for his interesting report of the excellent work that was being done on the station.

In view of the expansion reported, and of the development of the Sugar Industry in the Provinces, it seemed not improbable that a considerable increase of staff might be necessary in the near future.

SUBJECT VIII.—RICE—A PRELIMINARY DISCUSSION OF THE WORK ALREADY DONE IN THE VARIOUS PROVINCES ON THIS CROP AND THE CONSIDERATION OF A WORKING SCHEME FOR FURTHER INVESTIGATION SO AS TO PREVENT OVERLAPPING.

26. The Committee consisted of :—

Mr. Chadwick (Chairman), Messrs. Burns, Harrison, Hector, Hooper, Meggitt, Parnell, Sampson, and Sherrard.

The terms of reference were :—

To make recommendations.

Mr. Chadwick read the Report, as printed below, contrasting its shortness with the importance of the subject and referring to the relative importance of the crop in the different provinces and the very different conditions under which it was grown in different tracts,—technical terms used in one tract having no equivalent or meaning in another—and mentioning briefly the different aspects from which work had been taken up.

Most work had been done on the manurial side, and the report dealt chiefly with this.

Dr. Pillai having proposed a preliminary division of investigations based on the fact that he was not aware of important work that had already been done in Hawaii and Japan,—which had demonstrated the inutility of nitrates for paddy, Mr. Harrison referred him to the work in point.

Mr. Wood suggested and **the Board agreed that a note be recorded recommending the adoption of universal standards of weights and measures in publications of the Department.**

It was decided to record this **with special reference to Programmes ; and that the implication should be extended to the names of crops and other technical terms as far as possible.**

In reply to Mr. McSwiney, Dr. Butler explained the present position of the investigation of *Ufra* in Bengal, which had been retarded by insufficiency of staff and Mr. Smith's absence on leave, and which would be set back a whole year if Mr. Smith were not able to attend to them at the present time, Dr. Butler being unable to do so.

The report was accepted as given below :—

27. In order to facilitate discussion of the work already done in the different Provinces and of the problems connected with this crop, the Committee reviewed the subject from the agricultural, botanical, entomological and chemical standpoints and their report follows this division for sake of convenience. The Committee are of opinion that in all problems connected with rice there should be, as there has been in the past, close co-operation in work between all sections.

Since rice is cultivated under such vastly different conditions in the various Provinces and even in some cases in different parts of the same Province, the Committee consider that each Province must work out for itself the problems connected with cultivation and the methods of cultivation. But on the manurial questions, the general experience appears to be in favour of green manuring when paddy is transplanted. Bonemeal also, is, in many Provinces, reported to give good results, but general experience appears to be against chemical nitrogenous manures except cyanamide and possibly sulphate of ammonia.

In the opinion of the Committee, investigations into the local seed rates in vogue in the various Provinces are often of importance in themselves and are likely to become still more so, if improved varieties are developed later by the work of the Botanists and Agriculturists. For, in that case, seed farms in the districts may be necessary to establish the new varieties, and if the seed rate in the villages has been reduced, the effective range of such seed farms will be increased.

Seed selection should, in the opinion of the Committee, be done under control at the Agricultural Farms.

It appears to the Committee that botanical classification is only of importance as a means of reference for the local worker. The task of forming a complete botanical classification would be a very heavy one. But as a preliminary step, each Province should work out for itself an agricultural classification by which the Committee mean a classification based on characters other than purely morphological.

The object to be kept in view in botanical or seed selection work is, in the opinion of the Committee, the production of improved strains of the more important varieties to be found in the chief rice-growing tracts of each Province.

Considerable work has been done on the fungi and insects which affect rice. Although the loss resulting therefrom frequently appears to be only local, yet the total annual loss is considerable and it is desirable, in the opinion of the Committee, that work on diseases and pests of rice be given a prominent place in the work of these sections and especially a study of the conditions which favour the origin and spread of such diseases and attacks.

The Chemical sections in Burma, Bengal and Madras have all started on useful and practical lines of enquiry which should, it is recommended, be continued.

On the general question of overlapping, the Committee considers that the problems connected with rice are so wide and all important that there is little danger of overlapping and were it to occur it would be to the direct advantage of every one.

SUBJECT XII.—FRUIT CULTURE IN VARIOUS PROVINCES.

28. The President placed this subject before the Board for an informal discussion.

He asked Mr. Robertson-Brown to address the Board on this question.

Mr. Brown said fruit culture was at present neglected, and suggested that it rested with the Board to decide whether anything should be done before 1916.

This was a vegetarian country; each province produced some kind of fruit in great abundance and there were large markets in India. After mentioning the work in progress he asked the Board to pass a Resolution recommending :—

(i) a survey of fruits,

(ii) the establishment of fruit orchards at Agricultural Stations,

(iii) training of Fieldmen and Assistants in fruit work.

He said a survey of peaches had only meant a few months touring, and had given very valuable results; fruit formed a very important group of crops, and few people knew anything about fruit growing; while it would be easy to train men.

Mr. Burns supported the proposal and remarked on the high value and paying nature of a fruit crop compared to the ground covered. He said that good markets undoubtedly existed and it was remarkable and significant that the larger the market the higher the price, and the export market had hardly been touched. In spite of the magnitude of the demand the quality supplied was low; there was undoubtedly a demand for trained men; he received 20 or 30 applications in the year and could not supply the men.

Mr. Birt and Mr. McSwiney deprecated the idea of laying stress on garden products in connection with this Department's work. They maintained that any resolution of the Board urging the importance of fruit growing would encourage the idea already prevalent, especially amongst Europeans, that one of the main objects of an Agricultural Department is to devote itself to the cultivation of fruit to the neglect of more important food crops.

Mr. Hailey agreed, and suggested that the gardeners' service could deal adequately with fruit in most provinces—a view which was vigorously contested by Messrs. Brown and Burns.

In reply to Dr. Barber, who viewed Mr. Brown's work at Peshawar with the greatest sympathy, Mr. Brown said he had distributed 50,000 budded peaches alone.

Dr. Leather and Mr. Smart having suggested the inclusion of the canning, packing and transport of fruit in the reference, and there being a strong feeling that some definite resolution should be passed, **the following resolution was approved by the Board :—**

In Provinces where the fruit trade is considered of importance sufficient to justify an extension of this Department's activities in the direction of fruit investigation, and where the gardeners' service is unable to cope satisfactorily with the matter, a preliminary investigation should be made including :—

1. a survey of fruits,

2. the tentative establishment of fruit orchards at Agricultural Stations,

3. the training of Fieldmen and Assistants.

If such preliminary action lead to the systematic development of the fruit industry by this Department, questions of transport, packing, canning, etc., will have to be considered with reference to local conditions."

This closed the discussion.

FIFTH DAY.

SUBJECT XI.—SOIL DENUDATION BY RAINFALL, AND DRAINAGE : CONSERVATION OF SOIL MOISTURE.

29. The Committee consisted of :—

Dr. Leather (Chairman), Dr. Coleman, Messrs. Allan, Anstead, Harrison, Roberts and Robertson-Brown.

The terms of reference were :—

To make recommendations.

Dr. Leather read the report of the Committee on subject XI as follows :—

Soil denudation.—Mr. Anstead explained that in the European planting districts of Southern India the planters fully realise the importance of preventing erosion, and put in preventive works where it pays to do it, *viz.*, terraces, contour drains with catchment pits, and close growing green dressings along the line of the terraces.

Mr. Allan stated that the better cultivators in the Central Provinces fully realise the importance of preventing erosion, and keep bunds in order. In certain areas in the North of the Central Provinces bunding was a regular practice though not entirely on account of the prevention of erosion.

The Committee are of the opinion that the Deputy Directors of the Department are fully aware of the importance of the subject and feel that no advantage would accrue from recommendations made to them. They consider, however, that if notes were submitted to the next Board of Agriculture by the Provinces, on the extent of damage which occurs and the preventive methods practised, this subject might then be, perhaps, more completely dealt with.

Drainage.—The Committee take the term "drainage" to mean the removal of sub-soil water as distinct from surface drainage. Mr. Allan stated that he had improved the fertility of some low-lying black cotton soil at Nagpur by the use of tiled drains which he found efficient.

Dr. Leather mentioned that tiled drains had silted up at Saidapet and also at Aligarh and had for this reason proved useless.

The relation of drainage to heavily irrigated delta and paddy lands of Southern India appears to be of the greatest importance from the point of view of counteracting the increased tendency to salinity in these areas, and the direct effect of drainage on the growth of crops.

The necessity of drainage in connection with the schemes of canal irrigation in India is well known, but it would appear that sometimes insufficient attention is still paid to this matter.

The Committee recommend that the local Agricultural Departments should be consulted in all future irrigation projects so as to ensure that adequate attention is paid to drainage arrangements.

Conservation of Soil Moisture.—The Committee have no very specific information on this subject though it appears that the members of the Agricultural Departments are fully aware of its importance. They recommend that when the subject of soil denudati n is again discussed by the Board more complete information on this one should be called for.

30. In reply to the President Dr. Leather said the Committee thought that Mr. Howard's note on the subject should not be published as it was too general and the publication of such generalities with no reference to any large amount of specific information on the subject was to be deprecated.

As regards the term—Conservation of Soil Moisture—Dr. Leather said the term was misleading ; the degree of moisture in the soil could not be determined within 2 or 3 per cent. of the weight of the soil and he preferred the use of some such term as 'methods of soil cultivation in countries or periods of small rainfall '.

Mr. Wood referred to the drainage experiments at Saidapet and Aligarh, and mentioned two kinds of drains that had been made in the wet land at Coimbatore ; these had been done some years and were being dug up for inspection and would be shown to anyone who cared to pay a visit to the land—these,—rubble and bamboo drains respectively,—cost about Rs. 100 per acre. He did not know the cost of tile drains.

Dr. Mann elicited from Mr. Birt a statement that planters in Northern as well as in Southern India were familiar with methods of drainage and their value. An enquiry by Dr. Parr as to whether any definite work was being done in India on what might be called dry-farming, evoked a reference to Mr. Howard's work at

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Quetta where the conditions of the water in the sub-soil appeared to resemble those said to maintain in the best dry-farming areas in Western America and where the rainfall is more or less consistently insignificant. With reference to experiments in Bombay, Mysore and other places of moderate but uncertain rainfall, Mr. Milligan, called on by the President, expressed his opinion that this was a matter of the evolution of standard farm practices; local conditions varied and practices must be varied accordingly. In this view Dr. Coleman and Mr. Wood concurred; such development of routine methods required local demonstration rather than reporting of the results.

Dr. Coleman gave the Board an instructive account, which was greatly appreciated, of his attendance at the Dry-Farming Congress in America. He thought people in India were as alive to the importance of the subject as the Americans, but the chief impression he obtained was of the inadvisability of such propaganda as those of the Dry-Farming Congress.

In reply to Mr. Smart, Mr. Wood advocated selection, for drought resistance, from among locally grown crops rather than the trial of exotics,—which he thought could not justify such expense as was incurred in importing plants into America. Dr. Coleman pointed out the differences in the position of India and America as to this; American agriculture being comparatively new and nearly all American crops being imported.

III. He proposed **a resolution, "that the Board consider that sufficient information is not as yet available to enable them to frame recommendations on this reference. They would suggest that the subject be brought up at a future meeting of the Board and that further information be collected": this was passed unanimously.**

SUBJECT IX.—AGRICULTURAL EDUCATION.

31. The Board then took up Subject IX—Agricultural Education.

The Committee consisted of:—

Mr. Mackenna (Chairman), Sir Alfred G. Bourne, Drs. Barber and Mann, Messrs. Allan, Barnes, Burns, Clarke, Dobbs, Hamilton, Milligan, Roberts, Sampson, Wood and Woodhouse.

The terms of reference were:—

(a) *For what classes of persons should education be provided at the Agricultural Colleges and what general forms should such education take?*

(b) *In what respects is the present college education deficient and how should this be remedied?*

(c) *What additional agricultural education, if any, should be provided outside the colleges?*

Note.—In this connection the proposed division of the Course in the Coimbatore College into two courses each of two years' duration can be considered (Appendix E (3), page 170).

32. The President in introducing the report of the Committee said:—

"I now rise to introduce the important subject of Agricultural Education. This is not the first time that this subject has appeared in our agenda. It was discussed in 1906 when the syllabus, which many of us are inclined to consider the root of our subsequent troubles, was first drafted. As I have said in another place, experience is showing that the courses originally prescribed in the standard curriculum for Provincial Agricultural Colleges as laid down by the Board of Agriculture in 1906 and amended in 1908 are, in most cases, not suited to the class of students that the colleges are intended for. Provincial reports are almost unanimous in tone. In Bombay, while the percentage of passes in examinations is high, the question of the utility of, and demand for the course is obscured by its being made a road to a degree. College graduates on the subordinate staff have, with very few exceptions, continued to show no power to develop any original line. In Madras, there is noted in graduates a lack of intelligent inquisitiveness and power of independent thought. Similarly in the Punjab, there is too much cram and too little power of practical application.

"There are some who see in this a proof of the limitation of the capacity of Indians. But others not only refuse to take this pessimistic view, but have always held and expressed the opinion that an attempt to teach up to the Standard Syllabus prescribed by the Board of Agriculture in 1906 was bound to end in failure. The principal objection to this syllabus, in the opinion of many of us, is that it consists of a number of independent courses each complete in itself and all compressed into the allotted time, without any reference to the capacity of the students in general, or of Indians, in particular, or to the limits to which any of the subjects can be pursued with advantage in a general education or by practical agriculturists.

"Touring over India, as I have been doing during the past year, the impression was strongly made upon my mind that, while we may have had some successes, it was desirable that our general policy should be reviewed. The papers submitted by Mr. Barnes and Mr. Woodhouse clearly show that this anxiety is also shared by some of those who are most closely associated with Agricultural Education. We have, therefore, determined to face the subject, and the question has again been reviewed in all its aspects by a strong Committee of the Board.

"To pave the way for this general discussion, it seemed desirable that we should first have an expression of opinion from Deputy Directors as to the difficulties with which they meet in dealing with cultivators. Here we are at once confronted by the very small proportion of literacy amongst the cultivating classes of India. It would be interesting to know, for all Provinces, up to what ages and to what extent children attend school. Figures for Madras are probably typical of conditions in many other Provinces. In Madras, of 500,000, children who enter the infant class, only about half pursue their educational career further. We may venture to hope that sooner or later, the spread of education may improve the situation, but at present it seems clear that the only way to get at this great uneducated mass is by demonstrating things in their own fields.

"When we get away from the small cultivators, it is pleasing to find that in certain Provinces, there is a growing demand on the part of large cultivators or landholders for an agricultural education of some kind. The Coimbatore College has framed a scheme which seems to meet the requirements of this case. That this class, however, would come forward in the numbers anticipated when the Colleges were erected has conclusively been proved to be a wrong assumption, and the Committee have expressed the opinion that for the present, Colleges must be considered principally as training grounds for the staff of the Agricultural Department. There is no doubt that much disappointment has been caused by the failure to attract this class to the extent anticipated ; although this is a source of supply which it is hoped we shall later be able to draw on.

"As will be seen from the detailed report which I shall presently read, it seems clear that our failure has been due to attempting to enforce uniformity in all Provinces. We have attempted to apply to all Provinces similar educational training, whatever the educational standard of the Provinces or the state of development of scientific agriculture might be. In these attempts, we have failed: we have tried to build from the top rather than from the bottom. We have assumed on the one hand that research was sufficiently developed to provide material for teaching, and on the other that the general education of the Province was such as to permit of the assimilation of such training : conditions which exist in few, if any, of the Provinces. In some the standard of English education is higher than in others : in some agricultural research has been going on for many years, in others it has just begun. The Committee has made an effort to lay down principles which, without affecting Colleges which appear to be working satisfactorily and to be attracting the right class of student, will enable others to reconstruct their curriculum on lines adapted to the educational capacity of their students.

"Uniformity, in fact, will not be insisted on : but it will be open to all Provinces to reconstruct their educational policy on the lines which they consider most suitable to attract the right class of pupil. If, in the earlier stages, Provinces are not hampered by having to work up to what in the existing conditions of education and local research might be regarded as a practically unattainable ideal, but are permitted to adapt these courses to the local conditions, then I see no reason why, from this well-laid foundation, we should not later get a superstructure much more satisfactory than we have obtained in the past."

33. The President then read the report of the Committee, of which he had himself been Chairman, which is printed below :—

1. In accordance with the proposals contained in paragraph 20 of the Agricultural Adviser's Note on Agricultural Education a preliminary meeting of Deputy Directors of Agriculture was held at Coimbatore on the 6th of December. Representatives were present from Pusa, Madras, the Central Provinces, Bombay and Bihar and Orissa. The Deputy Directors from Burma and the United Provinces were unfortunately unable to attend; while the Deputy Director from the Punjab was not summoned as he was not a member of the Board and the distance from Coimbatore seemed too great to call him for the special purposes of the Sub-Committee.

The Sub-Committee accordingly consisted of :—

Mr. J. Mackenna (Chairman), Sir Alfred G. Bourne, Dr. Parr, Messrs. Birt, Clouston, Dobbs, Evans, Gonehalli, Milligan, Sampson and Sherrard.

2. The points submitted for their consideration were :—

(a) *What difficulties are met with in dealing with cultivators which can be ascribed to defective education and in what respects is the education of cultivators defective?*

(b) *What assistance can the Agricultural Colleges give in educating the cultivators, generally or technically?*

(c) *What educational and practical qualifications are required in recruits for the staff of the Agricultural Department? Can they be classified into grades of different educational qualifications?*

Under the first reference, the Deputy Directors were of opinion that, as regards the small holder, his education is not sufficient to enable him to appreciate economic factors and to benefit by the Department's propaganda. The present education of cultivators seems to the majority of the Deputy Directors to be defective in that their power of observation and reasoning faculties are not sufficiently developed and they are, therefore, unable fully to appreciate the Department's propaganda except in cases in which demonstration in their own village fields is possible.

With regard to the question "whether more education is required and, if so, is it only general elementary education or is any special education supervised by the Agricultural Department, on the lines for instance of the Bombay Vernacular Schools, generally required," the Deputy Directors' Committee considered it advisable to await the results of such experiments before expressing an opinion.

The Deputy Directors consider that elementary education should be of a general nature and is not within the purview of the Agricultural Department, but the Board should express the willingness of this Department to confer with the Educational Department and to discuss the question of the adaptation of rural education to rural conditions.

3. With regard to the question whether there is any considerable number of large cultivators or landholders who would benefit by a special education not obtainable in schools and colleges under the Educational Department; the Deputy Directors note that in Southern India there is a demand on behalf of landholders for an agricultural education, which the Deputy Directors consider, should be almost entirely practical and which might be on the lines of the new curriculum proposed for the first two years of the Coimbatore College course.* This course is susceptible of considerable adaptation or modification. Short technical courses should be arranged for separately, if necessary and desirable. This conclusion disposes of the reference "What assistance can the Agricultural College give in teaching the cultivator, generally or technically."

4. With regard to the third reference, *viz.*, "What educational and practical qualifications are required in recruits for the staff of the Agricultural Department and can they be classified into grades of different educational qualifications," the Deputy Directors' Committee are of opinion that educated recruits for the Departments' District staff can be classified into (1) Lower Subordinates, and (2) Upper Subordinates. For the former the training given in such a course as that proposed for Coimbatore, mentioned above, should qualify such recruits for appointments as probationers. Where such or similar training cannot be given, Deputy Directors should be allowed to select men for training on their farms without reference to any specific educational qualifications always bearing in mind that men who have been brought up on the land will usually be most suitable.

For the Upper Subordinate class, the best men possible are required. The necessity is recognised for a sound agricultural knowledge and training, and where a considerable number of men pass through the Agricultural College course a sufficiently wide field for selection will, no doubt be provided. In Provinces in which this cannot be secured the Deputy Directors are of opinion that selection should not be confined to men who have passed through Agricultural Colleges.

To this Messrs. Milligan and Dobbs added a rider as follows :—

"Character, energy and common sense are more important than any scientific qualifications.

"So far as these can be developed by education, manual training and general elementary science are likely to be useful, and the two years' practical course proposed might be made to meet requirements.

"But in addition to this, the object of education is to develope intelligence, and to do this as fully as possible a very considerable amount of training in deduction and induction on formal systematic lines is necessary.

"Not only so, but for the duties of an ordinary experimental Farm Superintendent, a grasp of elementary mathematics far more complete than that shown by students in the Punjab and Bihar is essential.

"From our experience of these students and of Farm Overseers and Managers, we consider that this deficiency will best be supplied by a course in pure and applied elementary mathematics

* See Appendix p. 170.

(including the principles of elementary general science) on the lines of the Sub-Overseers' course in the Sibpur College. If any considerable amount of manual training and carpentry and fitting could be included in the preliminary course, the workshop course of the Sibpur curriculum might be omitted."

5. The Committee met on the 8th, 9th and 10th December and considered the points referred to them in the light of the foregoing recommendations of the Deputy Directors.

6. *Reference (i).—Classes of persons for whom education should be provided at Agricultural Colleges.*

After reading the Deputy Directors' findings, the President gave figures showing the destination of students who had passed through the Agricultural Colleges in various Provinces. On the first reference the Committee adopted the general classification of students into two classes as proposed by the Deputy Directors and agreed that for the first class, namely the sons of land-holders who intend to take up farming and for recruits for the lower subordinate staff of the Department, a curriculum on the lines of that proposed for the first two years of the Coimbatore College course was suitable. It was considered that, for this class, the qualifications for entry should not be too high, but that the stipulations as regards additional qualifications in the case of students who proposed to take up the more advanced course proposed for two further years at Coimbatore were essential to success.

7. After a lengthy discussion of the number and quality of the men now passing through Agricultural Colleges in India and of the demand for different types of agricultural education, the Committee agreed that the Colleges must, in their early stages, be considered principally as training grounds for the staff of the Agricultural Department. The second class suggested by the Deputy Directors may be sub-divided into two groups, namely :—

(1) The sons of men of independent means who require an education for its own sake.

(2) Upper Subordinate recruits.

Colleges should cater for both, or for the second only of these, according to the circumstances of the Provincial Department.

8. *Experience of Agricultural Education in India up to the present time.*—After a thorough discussion of the capacity of the students entering the various agricultural colleges particularly as regards their ability to understand lectures in English, the Committee recorded its opinion that the education of the country up to the Matriculation standard, does not provide a sufficient basis on which such higher education as these last two classes of men require, can be founded. It is, therefore, the Committee consider, necessary either to give students a further general education (particularly in English and Mathematics) after admission to the College, or to insist on such higher general education before admission.

At the same time the Committee wish to emphasise the gravity of the danger of attracting a class of men who have no connection with the land.

9. Incidents of the discussion up to this point having made it clear that there was a very strong feeling on the part of many members of the Committee, that the Committee was ignoring the principal fact emerging from the history of Agricultural Education in India—namely that it was the record of an experiment from which it was the imperative duty of the Committee to draw lessons as regards the conditions of success or failure,—the feeling was crystallised in the following formal resolution :—

"*The Committee have read the notes *presented by Mr. Mackenna and Mr. Barnes and have had before them Mr. Woodhouse's presentation of the situation in Bihar. From these it is plain that one of the principal causes of the failure of some of the Agricultural Colleges to attract students, in any considerable numbers, has been the lack of a preliminary wide development of the experimental and district work of the Agricultural Departments. Until such experimental and district work has been much more developed and a large number of trained officers of high calibre have been working in the Provinces for a considerable time, it is, in the opinion of the Committee, unwise to attempt to carry out a high scientific course at these Colleges. When such work, under such officers, has been developed, there is every probability that the right class of student will be obtained and it will be possible to train men to the highest possible point in the sciences applied in Agriculture,—but until this is the case a simpler course will probably meet all the existing needs for Agricultural Education.*

"*As a sequel to the above, a considerable expansion of the superior staff in all Provinces and in all sections of the Department seems desirable. This will naturally be followed by a corresponding increase of the subordinate staff, which can, ordinarily, be trained at the Colleges.*

"*The Committee is, however, of opinion that the present pay and prospects of the subordinate staff of Departments in most Provinces are not sufficiently attractive, and should where necessary, be increased.*"

10. This resolution was adopted after mature consideration by the members of the Committee, which had adjourned for the purpose of individual consideration of the consequences of giving effect to a Resolution of the kind.

It was felt that expansion of the Department's work on the lines suggested would provide, not only fresh materials for a simple course of the kind already approved, but also the only justification for the provision in every Province of a higher agricultural education than can, at present, be given in some Provinces with due regard to efficiency and economy.

11. The Committee then went on to discuss further the general forms of education that might be provided at Agricultural Colleges for the classes of men agreed upon.

The curricula at present in force in the Provinces were framed in the light of the following Resolution of the Board passed in 1906.

"The Board considers that some form of degree or diploma should be conferred by Provincial Agricultural Colleges. In view of the danger that diplomas conferred by individual colleges should have a different value, and *to secure uniformity*, it suggests that a combined diploma should be given, and that the Government of India be moved to recognise it as equal to the B. A. degree. As regards the exact title conferred, the Board consider that some such title as Licentiate of Agriculture (L. Ag.), may suitably be given."

* Appendix E (1), (2), and (4), pp. 148-169, and 172-178.

The curricula were, therefore, made to conform generally to the 'Standard Curriculum' recommended by the Board in 1906 and amended in 1908.

In view of the wide difference of conditions in different Provinces brought to light by the comparison, during the discussion, of the experiences since gained by the several members of the Committee, the Committee are of opinion that it is essential to allow greater latitude (than is compatible with the spirit of the Resolution quoted), for the development of agricultural education in the Provinces on a firm basis with reference to local conditions.

12. *General forms which agricultural Education in the Colleges should take.*—They consider that independently of, or including, such a simple course as that already approved—and which may, for convenience be called course "A",—there is scope for a diploma course which we may call "B", and which may extend over three or four years; but that this should be given only in those Provinces where considerable advance has already been made; and in which—

(*i*) sufficient investigation into local agricultural conditions has been carried out and material for teaching thus provided,

(*ii*) a qualified expert staff for investigation and teaching exists, and

(*iii*) students able to profit by such a course will be forthcoming.

A third form of course which we may call "C" would comprise short technical courses in subjects of general importance in any Province—for example, dairying.

The Committee also note with satisfaction that an elementary agricultural class for junior members of the Indian Civil Service is held in some Provinces.

13. *Reference* (*ii*).—The Committee consider that the second of the terms of reference has been sufficiently dealt with in the foregoing recommendations. (Paras. 6 and 7.)

14. *Reference* (*iii*).—*Agricultural Education outside the Colleges.*—Coming now to the third of the terms of reference, and as regards agricultural education in general, the committee endorsed the recommendation of the Sub-Committee of Deputy Directors of Agriculture 'that the Board should express the willingness of this Department to confer with the Education Department and to discuss the question of the adaptation of rural education to rural conditions.'

15. Specific Agricultural Education outside the Colleges can be divided into—

(*a*) short courses which will generally be in the Vernacular,

(*b*) Agricultural School courses.

The first can be given on any farm where adequate supervision is available.

As regards the second, they would have the best chance of success if they were given, initially at any rate, under the management of the Agricultural Department.

In Bombay, an interesting experiment has been made in the establishment of one Vernacular Agricultural Boarding School. This was established four years ago and is capable of accommodating 50 boys, aged from 14 to 16, for a two years' course. The boys admitted are the sons of village headmen, small land-owners and the like. The Head Master is an Agricultural Graduate and he has an assistant provided by the Education Department. It has so far not been difficult to attract the class of boys desired and those who have gone out have almost invariably gone back to the villages and to the land. It is necessary, however, to emphasise the fact that very close supervision is necessary for such a school.

The Committee desire to commend this interesting experiment to the notice of the Board.

34. Having read the report, the President said he proposed to ensure the discussion of certain definite points in the Committee's report by asking those members of the Board who were primarily interested in these points to move resolutions: the discussion of any other points which members might wish to raise could then be taken up.

He called on Mr. D. Clouston who moved **a resolution that "The Board desire to express their approval of the proposed two years' preliminary course for Coimbatore College, and suggest it as suitable for the consideration of other Provinces."**

Mr. Clouston said :—

"I welcome the findings of this Committee as given in paragraph 6 of their report as I am convinced from what I know of the different Agricultural Colleges in India that the present syllabus is unsuitable. Men of lower educational qualifications than the matriculation standard cannot assimilate the more scientific part of the course: many of those who have matriculated find the course so hard that they give it up in despair, and few who pass can be said to have understood what they have learned.

"The difficulties have become widely known and it is now becoming harder every year to get the number and type of men we want.

"Speaking for the Central Provinces I can say that the men who persevered and completed the three years' course of the present standard curriculum and who were taken into our department were not the kind of men we wanted. The services of many of these have been dispensed with at the end of their probationary period as agricultural assistants, and we have had to keep on many who are

below the mark because of their having been drawn from the non-agricultural classes. The present standard course is such a formidable one that it shuts out the class of men we want. It provides too little of the practical work which they like, and too much of the purely scientific study which they fail to understand.

"The two years' course proposed should serve a sound and practical one for men qualifying for the lower subordinate service. It will be a good preliminary course for men who intend to take the full four years' course and to qualify for the upper subordinate and provincial service. It will be a good serviceable course for men who wish to get a training for posts on Court of Wards Estates and perhaps, what is most important of all, it will be a course which some of our enterprising landowners will take with advantage.

"The wording of the findings of the Committee makes it plain that the course has been framed to suit the requirements of Madras only but other Provinces will no doubt consider the advisability of modifying their own college curricula on the same lines."

The resolution was seconded by Mr. Wood, and after a short discussion which made it clear that while the Deputy Directors had approved the course referred to as likely to give certain qualifications, there was no intention of suggesting that such a course should be given at every Provincial College, the resolution **was passed unanimously**.

35. The President then called on Mr. Barnes, who said :—

"In rising to ask the Board to support the opinion of the Committee as expressed in paragraph 8 of the report I wish to endorse the remarks of the Chairman in opening the discussion. Some provinces have already realised the necessity of the resolution I am about to submit to you and have taken action on the results of their own experience, for instance Bombay. For the same reason others are at the present moment meditating alterations of the syllabus, as for example in the Madras Agricultural College. My own special experience, which has been confined to the Punjab, is that a student's progress in the Agricultural College is hampered or assisted according to his general educational qualifications before entry to the College, other things being equal.

I have attempted to minimise the dangers and disadvantages of the examination system there by fixing a 40 per cent. pass on the final examination and in allotting 40 per cent. of the total marks to the whole work of the student during his three years' residence at the College, that is for progress and for terminal and sessional examinations. This renders it practically impossible for a steady worker, of adequate intelligence and preliminary training, to fail to get his diploma. It puts a premium on steady work and should stop cramming. In spite of the leniency which such a course extends to the student the examining board have for the past two years reported unfavourably on the ability of the student to show a proper power of applying the facts he has undoubtedly learnt. We attribute this partly to a top heavy educational system being based on an insufficient ground work, the chief defect being the student's lack of a knowledge of English and Mathematics and his consequent inability to form and express ideas relating to the technicalities of his studies. It is in my opinion essential that a satisfactory ground work of education should be possessed by the student before he enters on these higher courses, otherwise the time both of the teacher and of the student will be wasted in vain attempts to train him. The first resolution passed by the Board this morning indicates your opinion of the suitability of a preliminary two years' training—chiefly in practical agriculture—as a proper introduction to employment in the subordinate ranks of the Provincial Agricultural Service. Agricultural Education must go beyond this — it must provide an adequate and satisfactory means of training staff for the upper subordinate and, we trust in time, the superior branches of the service.

"These men must possess such a groundwork of education as will enable them to assimilate (in its widest sense) the higher courses of instruction imparted in Agriculture and the Agricultural Sciences. I believe I am expressing our united opinion when I say that where there is a preliminary two years' course as in Madras admission to this lower class should carry with it no more severe restriction than that the student should come of a cultivating or landowning stock or be considered by the Agricultural College authorities a satisfactory recruit for the lower branches of the Agricultural Service.

"For the upper class, however, I ask you to endorse our opinion that in addition to the qualification necessary for admittance to the lower class the student should possess a sufficient knowledge of English and the elements of science, such as will enable him to benefit by the course of instruction imparted to him."

Mr. Barnes then moved **a resolution** which after some discussion **was agreed to in the following form :—**

"The Board endorse the opinion of the Educational Committee expressed in the eigth paragraph of their report that the general standard embodied in the Matriculation or University Entrance Examination does not provide a sufficient basis to enable a student to take full advantage of the higher instruction obtainable in the existing Agricultural Colleges in India. The Board recommend that a general higher education is necessary in all students admitted to such a course."

Mr. Roberts seconded the resolution. He said he fully endorsed Mr. Barnes' experience so far as assimilation of the course was concerned.

This matter was very fully discussed in the Sub-Committee. The general opinion, especially that of Madras members, was that the educational qualifications for the preliminary course should not be too rigid, as this might exclude desirable students. Such students would have an opportunity of improving in English and Mathematics during the preliminary two years' course and might thus be able to assimilate the advanced course. Whether the necessary standard was obtained before or after joining the preliminary course, it was most essential that it should be attained by those who intended taking and profiting by the advanced course.

Dr. Kunjan Pillai agreed that a higher qualification was necessary but suggested laying this down more definitely. He proposed the F. A. or Intermediate Standard.

Sir Alfred Bourne opposed the idea of recommending any specific standard. He thought it was entirely a matter for the Principal, whose judgment could be trusted as to whether the student possessed the necessary qualifications. One of the chief difficulties was that experienced by Indian students in understanding European intonation and pronunciation. The Committee has been in full agreement in insisting only that candidates should be able to understand the lectures given in English.

The resolution was passed unanimously.

36. The President then called on Mr. Woodhouse who moved **That the Board endorse the opinion expressed by the Commitee in the ninth paragraph of their report as follows :—**

"The Committee have read the notes presented by Mr. Mackenna and Mr. Barnes and have had before them Mr. Woodhouse's presentation of the situation in Bihar. From these it is plain that one of the principal causes of the failures of some of the Agricultural Colleges to attract students in any considerable number has been the lack of a preliminary wide development of the experimental and district work of the Agricultural Departments. Until such experimental and district work has been much more developed and a large number of trained officers of high calibre have been working in the Provinces for a considerable time, it is in the opinion of the Committee, unwise to attempt to carry out a high scientific course at these Colleges. When such work under such officers has been developed, there is every probability that the right class of student will be obtained and it will be possible to train men to the highest possible point in the sciences applied in Agriculture, but until this is the case, a simpler course will probably meet all the existing needs for Agricultural Education.

"As a sequel to the above a considerable expansion of the superior staff in all Provinces and in all branches of the Department seems desirable. This will naturally be followed by a corresponding increase of the subordinate staff which can ordinarily be trained at the Colleges.

"The committee is, however, of opinion that the present pay and prospects of the subordinate staff of Departments in most Provinces are not sufficiently attractive, and should, where necessary, be increased."

In proposing the above resolution Mr. Woodhouse said :—

"As regards the first paragraph of the above resolution I think the time has come that the Board should make it clear that sound educational work can only be undertaken after investigation has provided the material; also that no attempt to attract students to an advanced course of instruction in Agriculture is likely to be a success unless successful demonstrations by the Department's staff in the district have advertised the fact that the course given in the College is likely to be profitable.

"The history of the Bihar Department provides a useful object lesson of the effects of violating the above principles. Fortunately it is possible to tell exactly what is the genuine economic demand for agricultural instruction in Bihar and Bengal, because only those students who propose to take up farming on their own account are admitted. No definite prospects of employment in the Agricultural Department or any branch of Government Service have hitherto been offered. At first a number of applications for admission were received, but, as it became more clearly understood that no Government Service was guaranteed, the numbers rapidly declined. It is now sufficiently clear that the public at present have no use for the agricultural education for the purpose of turning out prospective farmers.

"That there is no demand for the Sabour course is not so surprising when it is considered that the course is expensive both in time and money, and the Department has not yet proved that farming on a capitalistic basis is a paying proposition. Until investigation has proved what are the most paying systems of agriculture it is obvious that there can be no demand for advanced courses of agricultural instruction.

"As regards the reasons for the paucity of results obtained in the investigations conducted by the Bihar Department of Agriculture it appears to have been always thought that agricultural education is the primary work of the Department and any attempts to do investigation work in addition to teaching or office work have been looked upon as attempts to indulge in unnecessarily expensive hobbies at Government expense. With such a policy in view it can be understood that no attempts would be made to increase the district staff nor to lighten the burden of the teaching and routine work for the College superior staff. That the amount of routine work has been sufficient to prevent any number of the Scientific staff from doing much investigation work can be seen from the following statement.

"At the commencement of the last session there was one Deputy Director in charge of the whole of the district work of the Department including four farms under his direct control and five small farms which are carried on under his advice. The College staff consisted of a Principal, who is also Economic Botanist and is in charge of the Entomological district work; an Agricultural Chemist who also manages the well boring Department; and the Professor of Agriculture, who does some demonstration work with wheat in the Bhagalpur Division.

"Since the commencement of the Department's work the Deputy Director has never been able to do more than deal with the routine work of his office and routine inspections of his numerous farms, so that the level of the investigation work under him cannot be higher than the level of ability of his subordinates in direct charge of the farms, etc. The Agricultural Chemist on the other hand has been able to carry out some personal investigation work, and this was once the case with the Economic Botanist; but his appointment as Principal has made it impossible for him to carry on investigation work. The Professor of Agriculture is the fourth officer placed in charge of the teaching work and College Farm since 1908, so that no results of value can be expected from that farm as yet.

"It can be seen therefore that in the Bihar Department of Agriculture, everything has been subordinated to the educational work, and that has been directed to educating persons who were to use their education in cultivating their own land for profit. No proper steps have, however, been taken to investigate the local methods of agriculture with a view to its improvement. As a result the Department is not in a position to make more than a few general recommendations, and has only recently placed any successful demonstration to its credit. In consequence of this, there is no demand for advanced agricultural education, and never will be until the investigation work of the Department has been carried much further.

"As regards the second paragraph of this resolution concerning the necessity for a considerable expansion of the superior staff of the Department a useful moral can also be drawn regarding it, from the history of the Bihar Department. The failure of the farms in the Province (also in Bengal) to turn out useful results has been entirely due to their having been increased in number until their management has been left entirely to the subordinate staff, subject to occasional inspections by the Deputy Director. It is essential that each Deputy Director should not be burdened with more than one or two farms and should have as his circle a compact uniform tract no larger than he can get to know thoroughly himself. Sufficient Deputy Directors should be obtained to enable one to be placed in charge of each of the tracts of a Province which differ considerably in language and agriculture. In Bihar and Bengal the only portion of the Province which has been studied exhaustively by the Deputy Director is the railway line between the farms of Cuttack and Bettiah. Such knowledge has probably not an economic value in proportion to the cost of acquiring it.

"In the Colleges also it may probably be found that it will pay to divide the work of the Agriculturist into two or three portions such as Animal management, Arable farming, and perhaps Horticulture and Orchard management. The Botanist's work may also be specialised by the increase in the number of crop specialists.

"There is no doubt that the amount of progress made in the investigation work will be out of all proportion to the increase in the superior staff sanctioned provided that good men are obtained."

In seconding the above resolution Dr. Butler said :—

"I think that there is a wide feeling that we have been attempting to go too fast. In the beginning, when the Agricultural Department as at present constituted was organised, we had in many great areas practically a virgin field to work on in the development and improvement of the Indian Agricultural Industry. The natural tendency was a wide diffusion of energy in many directions. In certain cases obvious directions in which improvement was rapidly possible were soon detected and, as a result, we have the almost spectacular effects of the demonstration work in certain fortunate areas with which we are all familiar. This cream has been skimmed. But in being carried away by admiration for this work we are in danger of losing sight of what was ever present to our minds in the early days of the Department, that is, the laborious experiment and research which are necessary before any real raising of the level of agricultural practices in, at any rate, the more highly developed parts of the country was possible. It is clear that there are larger areas in which a teeming population are living by the practice of an agriculture which it will be exceedingly difficult for us—bearing in mind the special economic conditions of the people—to fundamentally improve. To carry out any real improvement in these areas it is evident that a large number of trained officers of high calibre must devote their energies to the study of the economics of farming under native conditions and to prolonged experimental research to determine how such farming can be improved. Until this is done what we have to teach the people in these areas is soon exhausted and the time appears to have now come when we must call a halt in these areas in our higher educational work. Until we have something new to teach, in the absence of any hope of gaining new ideas applicable to farming in such areas as Bengal and much of Bihar and Orissa and economically sound under the conditions of the people, we cannot expect to fill the Colleges with the right type of students for, at any rate, a high Agricultural Education."

The resolution being unopposed **was passed** without further discussion.

37. Dr. Butler then proposed that as a necessary consequence of the foregoing resolution, **the Board** should **revoke the following resolution, passed in 1906.**

"*The Board considers that some form of degree or diploma should be conferred by Provincial Agricultural Colleges. In view of the danger that diplomas conferred by individual Colleges should have a different value and to secure uniformity it suggests that a combined diploma should be given, and that the Government of India be moved to recognise it as equal to the B. A. degree. As regards the exact title conferred, the Board consider that some such title as "Licentiate of Agriculture" (L. Ag.), may suitably be given.*"

In seconding this proposal Mr. Sampson remarked as follows :—

"In 1906 when the curriculum was drafted which was to standardise the value of the Agricultural diploma throughout India, the Agricultural Department was so to speak in its infancy and it was not realised how much conditions vary in different Provinces, nor how greatly the conditions varied in Idnia from those in England where most of the members of the Board were trained.

"As the work of the Department has developed it has shown how important it is that men employed in its development should have had at least some direct connection with the land, and specially is this the case for men recruited to the District Agricultural Staff. In Scotlahd, the Scottish Board of Agriculture have found that for the development of agriculture there they required to recruit not so much men with merely a degree in Agriculture, but crofters' sons who with the basis of their agricultural upbringing, have been trained in scientific agriculture. If this is true in Scotland where I suppose that among the middle classes drawn from the county districts there are few who have not in some way been connected with the land, how much more is it so in India where the caste system has for generations defined the environment of mind and body of the people of the country.

"It is clear therefore that there is much greater difficulty in recruiting the right class of students to our Agricultural Colleges than there is to other educational institutions where a more general form of advanced education is given. We naturally want to draw from the country districts rather than from urban centres and from a class who at present have only to a small extent realised the value of secondary education and there is no doubt, I believe, that the development of education among this class varies very considerably in different Provinces, and in parts of the same Province, take for instance, in Madras, Malabar and the East Coast Districts.

"From this we see that the standard of admission to our several Colleges must vary very considerably and as this is the basis of further instruction the latter must also vary very considerably.

"My own experience in teaching Indian students is limited but in Madras the Deputy Directors examine the students at the College twice a year in practical agriculture and we find that often the men who do best here are those who cannot follow lectures on such subjects as Chemistry, Physics, Botany, etc.

"Several cases have occurred where such students have not been retained in the College on this account though they are just the class of men required for the District Agricultural Staff and just the class of student who would benefit by a simpler course if he went back to the land. Therefore I have great pleasure in seconding Dr. Butler's proposal."

This proposal was also **agreed to** without further discussion, the President explaining that the revocation of the Resolution of 1906 in no way affected Colleges which were successfully working up to the Standard Curriculum.

38. The President then called on Dr. Coleman, Director of Agriculture, Mysore State, who said :—

"I have the honour of proposing the following resolution for adoption by the Board of Agriculture.

"**Resolved that the Agricultural Board, while agreeing that the teaching of agriculture as such in primary rural schools is fundamentally unsound, consider that the question of a sympathetic co-operation between the Educational and Agricultural Departments in adapting rural education to rural needs is of great importance. In consequence they desire to endorse the recommendations of the Deputy Directors' Sub-Committee as to the willingness of the Agricultural Departments to confer with the Educational Departments and to discuss this important question.**"

"I propose this resolution with some diffidence from the fact that we have with us a very distinguished member of the Educational Service whose mature views on this subject I have not had the opportunity of ascertaining.

"There are, however, certain very definite facts with which we are face to face and which it seems to me make this subject one of supreme importance.

"In the first place I need hardly state that the great bulk of the population of India is agricultural and is almost certain to remain so for many years to come. Primary education as it extends will therefore become more and more a question of training a rural population.

"In the second place the education provided by agricultural colleges and even by special agricultural schools will, in all probability, within the next hundred years at least, reach but a very minute proportion of the agricultural population.

"Thirdly the only general method at present open to the agricultural departments in India to educate the agricultural masses is by direct demonstration in the villages. The demonstrations so far carried out have been of definite and simple facts and, as the Sub-Committee has pointed out, the present education of cultivators seems to be defective in that their powers of observation and their reasoning faculties are not sufficiently developed to grasp even simple principles involved in agricultural improvement. This means, I take it, that the practical work of the agricultural departments will be restricted until such time as these unfavourable conditions with regard to the education of the cultivators have, by the extension of general education, been removed. In this connection I would recall the remarks already made by Dr. Butler that before we can go very far in the development of agriculture in India there must be a very great extension of research and investigation. In turn, to bring the results of such extended investigations home to the people, we shall have to have a much more enlightened and receptive agricultural populatiou than we have at present. Thus the question of furthering agricultural development in India is most intimately connected with imparting an education to the agricultural classes adapted to their particular needs.

"Lastly we are face to face with the fact that primary and secondary education is already slowly but surely extending in rural communities and it is of the utmost importance that such education should be begun on sound lines.

"I take it that the resolution which I have the honour of proposing simply expresses the strong desire of this Board that education in rural communities should be so inaugurated and carried on that the difficulties mentioned by the Sub-Committee in the way of a rapid introduction and extension of agricultural improvements should be removed as rapidly as possible. How that desired end can be attained must depend very largely on local conditions but it is certainly a question which should interest the Educational and Agricultural Departments equally strongly and in the solution of which there is wide scope for co-operation between these two great educative agencies of the State.

"While I have strong views with regard to the procedure which should be adopted in the State which I have the honour of representing here, views which I have already given expression to in a report which is in your hands,* I think it would be unwise for me to make any more definite remarks until we have had the opportunity of hearing the views of the Hon'ble Sir Alfred Bourne who I am sure will be able to furnish us with most valuable advice on the subject."

The resolution was seconded by Mr. Clouston and supported by Sir Alfred Bourne who said that a feeling was widespread that the progress made in disseminating information as to agriculture and improved methods in agriculture was very slow and the Educational Department was frequently urged to "go faster."

The method suggested was to filter the information through a series of teachers and teachers were to attend Agricultural Colleges and to go out and teach agriculture to other teachers in training schools who in turn would teach this subject in village schools.

The system would be unsatisfactory. It was impossible to teach everything in these village schools. The Education Department were being pressed to teach, besides Agriculture, Hygiene, Morals and many other subjects. Further if "Agriculture" were taught, filtered down in this way, the knowledge imparted would be somewhat curious.

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* Report on Agricultural Education by Leslie C. Coleman, M.A., Ph. D. Bull. No. 3, Dept. of Agri., Mysore.

The most satisfactory way of increasing the rate of distributing knowledge of the subject would be to develop the system of demonstrating methods to adult cultivators on demonstration farms.

Co-operation between the Agricultural and Educational Departments should not be understood to mean that the latter was to teach the discoveries of the former.

The co-operation which should be developed was detailed in the Report of a Committee of the Board of Agriculture appointed to deal with the subject in 1910,* with every word of which he agreed :—

" 1. *Agricultural Schools for Primary Teachers.—The Agricultural Department is at present asked to assist in finding suitable instructors to teach nature study in the training institutions for primary teachers. But it has as yet no further connection with the training schools ; and its officers do not see the teaching which is given by the instructors whom the Department has recommended. The committee think that the Agricultural Department might offer its services to the Education Department to take part in supervising these courses of instruction at the training schools. In their opinion such co-operation may be of assistance in keeping these classes to the object which they are intended to perform,* viz., *to prepare good rural teachers for primary schools, able to teach country children to observe and think about familiar objects of rural life, and able to illustrate their lessons by a properly kept school garden ; and the co-operation proposed may also be of assistance in preventing these classes at the training schools from being misdirected towards the object of providing a course of instruction in agriculture or demonstrating particular agricultural improvements. The Agricultural Department might usefully confer with the Education Department as to the courses of nature study followed at the training schools, the text books used, the practical work prescribed, the provision and up-keep of a model school garden at the training school and the lessons given to the students under training ; and possibly also as to the selection of the students who should undergo such training in nature study, so as to limit the teaching to those who will profit by it and be able to apply it intelligently. The Agricultural Department might be invited to send officers, form time to time, to inspect the teaching of nature study as carried on in the training schools and to report upon it.*

" 2. *Secondary Schools.—Courses of Agriculture are offered in a few secondary schools in some provinces and are proposed in some other provinces. The syllabus of such courses has, as a rule, been drawn up with the assistance of the Agricultural Department : the instruction is usually given without further reference to the Agricultural Department, but in one province the schools, where it is given, have been recently visited by a Board of officers of the Agricultural Department. The Committee are of opinion that for the boys, who are to enter Agricultural Colleges, it is not an advantage, and most of the committee consider it a positive disadvantage that they should previously have received at school instruction in a course of agriculture. They recommend that the Agricultural and Educational Departments should confer upon the question whether these courses should be maintained as a means of providing agricultural teaching for boys who are not intended to proceed to an Agricultural College, and in the event of its being decided to retain them either in their present form or subject to modification, the committee recommend that the Agricultural Department should co-operate with the Educational Department in their supervision in the same way as has been proposed above in respect of nature study in primary training schools.*

" *With respect to the preliminary training of the boys who are intending to enter Agricutulral Colleges, the committee find that at present the chief deficiencies of the students lie in a lack of power to observe what is before them and to reason about it, an insufficient command of the English language, and also, but not universally, in a want of manual dexterity not in the coarser operations of the field, but in the finer work of the laboratory. So far as these deficiencies may arise from shortcomings in the secondary schools, it would not be within the power of the Agricultural Department to offer any assistance in their removal. The requirements of the Agricultural Colleges would best be met if the students before entering them had received at school a good general education including nature study, drawing and manual training, and including also a grounding in the rudiments of some science, preferably Botany*

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* Proceedings of the Board of Agriculture in India, 1910, page 65.

or Chemistry, taught practically. It appears possible that some assistance might be rendered by the Educational Department in bringing to the notice of the boys who appear suitable for an agricultural career, the facilities now provided by the Agricultural Colleges for pursuing an agricultural career; and if the Educational Department are willing to do this, the committee recommend that a paper containing the necessary information about the colleges and emphasising the qualities desired in the students, should be prepared by the college authorities, to be put into the hands of the headmasters of the secondary schools."

Continuing, Sir Alfred Bourne welcomed the idea of agricultural schools somewhat upon the lines of those in Bombay—schools wherein the staff was clearly suitable and where the pupils obviously wished to learn something about agriculture and were likely to put the knowledge acquired into practice, but pointed out that this was a very different thing from an attempt to teach agriculture as a subject of an ordinary school curriculum.

After some discussion in which Dr. Mann deprecated the unqualified condemnation by the Board of the teaching of agriculture in primary rural schools, and Mr. Gonehalli said he thought the broad facts of Agriculture and its improvements should be taught in primary schools, **the resolution was agreed to in the following form :—**

:III. **" The Board consider the question of a sympathetic co-operation between the Educational and Agricultural Departments in adapting rural education to rural needs to be one of great importance. In consequence they desire to endorse the recommendation of the Deputy Directors' Sub-Committee as to the willingness of the Agricultural Departments to confer with the Educational Department to discuss this important question. The Board also wish to endorse again the principles enunciated in the Report of Committee 'G' of the Board of 1910."**

:IV. 39. The President then moved **a resolution that " the Board desire to commend as worthy of consideration by Local Governments the experiment now being tried in Bombay of establishing Vernacular Agricultural Schools under the immediate supervision of the Agricultural Department."**

The Vernacular Agricultural School in Bombay was founded as the result of a statement made by the Director of Public Instruction in Bombay at the Provincial Agricultural Conference in Poona in 1909, that the Education Department was not prepared to undertake Agricultural Education of any kind. He suggested that if it was wanted, the Agricultural Department should do the work.

Dr. Mann formulated a scheme for an experimental Boarding School near Poona, which, with modifications, was accepted. This school takes boys of from fourteen to sixteen, for a two years' course. The boys must have passed the fourth vernacular standard, and preferably the fifth. They must be sons of village headmen, small land owners, and the like—but people who are not likely to be able to apply what they learn owing to poverty or other things are avoided. The course involves sixteen hours work a week on the farm and garden, which is run by the boys. The remainder of the time is spent in school, in a course which is partly a continuation of the ordinary school course, given with an agricultural bias and partly of special subjects, like nature-study and matters valuable in village life. The land they work is about 8 acres for a school of 40 to 50 boys. About 25 boys a year are admitted. They live with the Head Master who is one of the graduates of the Poona Agricultural College and a farmer by birth and training. A large part of the success depends on his personality. A second teacher has been provided by the Education Department and they have a field-man. The annual cost to Government is about 6,000 rupees and it has subsidies from District Boards, etc.

The idea has taken on in every direction. Another school is now being established in the Kanarese country on land provided by the local people and with promise of a number of scholarships. Another on slightly different lines is being established in the Konkan by a large land owner and several others are in negotiation. Sir David Sassoon of Bombay has founded an Agricultural trust, a large part of the income of which, is to be devoted to Agricultural Education given in the vernacular.

The President said he thought this was an excellent example of what could be done by the Agricultural Department to provide an Agricultural school education and should be commended to the notice of other Provinces.

Mr. Hamilton seconded this proposal, having ascertained from Dr. Mann that the age at which boys were recruited for these schools in Bombay was approximately that at which their education terminated in the ordinary High Schools in which the provision of instruction in Agriculture had just been condemned.

This resolution was also supported by Sir Alfred Bourne who said he hoped to see similar schools started in Madras.

Dr. Coleman ascertained from Dr. Mann and Mr. Smart that, though the Bombay Government had not allowed fees to be charged so long as the schools were still in the experimental stage, their popularity had been shown by the generous offer of scholarships at existing schools, and money for establishing new ones, some of which would be almost independent of Government financial support.

The resolution **was** then **agreed to.**

40. All the foregoing resolutions having been passed unanimously and as no member of the Board wished to raise any other point in connection with the Committee's report, Dr. Leather proposed and Dr. Mann seconded **the adoption of the report by the Board** and this **was** also **unanimously approved.**

The Chairman expressed the thanks of the Board to Sir Alfred Bourne for the valuable assistance he had given not only at the meetings of the Education Committee but in the discussion at the Board: he thought that, with the Board's assistance, Sir Alfred had finally disposed of any idea of introducing specific instruction in agriculture into the ordinary schools.

41. In the afternoon, the Board had the pleasure of listening to an interesting paper by Mr. Arno Schmidt on the question of cotton. A short discussion followed from which it appeared that there was a feeling among the officials most closely concerned, that the damping of cotton (*Kapas*) was on the decrease. It was practised only to a limited extent and was, from the directly commercial point of view, not so serious as Mr. Schmidt seemed to think, being a matter affecting domestic morality rather than international trade. It was admitted by Mr. Schmidt that Indian cotton is one of the driest on the European market.

A majority of the Board recommended that Mr. Arno Schmidt's paper should be published as an appendix to the "Proceedings" of the Board. (Appendix H, page 182.)

SIXTH DAY.

SUBJECT X.—THE DAIRYING INDUSTRY OF INDIA. HOW SHOULD THE VARIOUS SCIENTIFIC AND COMMERCIAL PROBLEMS INVOLVED, BE ATTACKED.

42. The Committee on Subject X consisted of :—

Mr. Blackwood (Chairman), Dr. Mann, Major A. Smith, Messrs. Clouston, Milligan, Ram Gopal and Smith.

The terms of reference were :—

To make recommendations.

In introducing the report of the Committee on this subject Mr. Blackwood thanked Mr. Smith, Assistant Director of Dairy Farms, Army Headquarters, Simla, without whose assistance the report could not have been produced in its present form. The Committee had avoided, as far as possible, trespassing on the subject of Cattle-breeding, though the suggestion as to the breeding of dual purpose animals was perhaps one of the most important in the report.

43. When the report had been read,* the President suggested the discussion of the recommendations one by one.

As regards the first, Mr. Wood objected to the word 'propaganda' (recommendation 1) as the Provincial Departments of Agriculture had not sufficient

* Printed below, p. 51.

information on the subject. Mr. Clayton agreed and proposed the substitution of the word 'programmes.' With this alteration, he endorsed the recommendation
XV. which was seconded by Mr. Chadwick as **a resolution,** *i. e.,* **"That dairying as a branch of agricultural science should, in future, occupy a prominent place in the programmes of the Agricultural Departments"**, and **was passed unanimously.**

With regard to the second of the Committee's recommendations, Mr. Heycock asked for specification of the lines which legislation should take. Dr. Mann proposed the addition of the words "against the adulteration of milk". Without such legislation no one would touch the industry; he instanced a case in which a large scheme had fallen through from the dread of fraudulent competition. Existing legislation in Bombay was too cumbersome. The Hon'ble Dewan Bahadur Swami Kannu Pillai suggested the encouragement of co-operative societies and Mr. Clayton said that the public were primarily interested and the recommendation which now ran "that legislative measures against the adulteration of milk, should be taken to protect honest traders and the public and to encourage capitalists and co-operative societies to invest money in the dairy industry" was discussed at some length. Mr. Sampson and others deprecated any measures that would tend to raise the price of milk. Dr. Mann agreed, but contended that his enquiries had shown that the price of the pure milk was already high and could not be increased by making purity more general. Mr. Smith endorsed this view and said milk diluted with skim milk in different degrees could be and was sold as such. Mr. Smart said dilution was sometimes advantageous and Mr. Clouston said the Committee thought the establishment of the industry on an honest basis would cheapen milk by attracting capital and improving the breeds. Mr. Smart proposed to limit the scope of the recommendation to the sale of adulterated milk as pure, in municipal and cantonment limits, but Mr. Chadwick and others pointed out that laws were commonly drafted to admit of putting them into operation when and where necessary.

Mr. Smart thought a general resolution that protective legislation was necessary would be enough and **the Board unanimously agreed** to the definite proposition put by the President **that some legislation was necessary.**

Referring to the opportunities for blackmail afforded by all such legislation Dr. Leather said relatively few highly paid and responsible officials need be employed to carry out legislation effectively on the system of taking samples privately as was done in England in the case of manures and so systematically tracking the chief malefactors. Mr. Dharamranga Razu who had owned a dairy for many years said there were an enormous number of small dairies in towns which it would be difficult to control; he thought legislation would be premature.

Colonel Hallowes suggested permissive legislation, so that big traders could register themselves under an Act.

Coming to the third paragraph of the report Mr. Milligan deprecated the discussion of excessive detail. He thought the problem of improving production lay at the basis of the whole question as in the case of many other industries, *e.g.*, that of sugar. Improvement of production should be the Department's first object in taking up the question and would go a long way to solve the problem. Dual purpose animals would be a great advantage and the question whether higher milk production and working capacity could be combined in one breed deserved a very careful consideration.

On this point Mr. Smith expressed his opinion that the two qualities were not incompatible though milk and beef production appeared to be so to some extent. The Sindhi breed, for their weight among the best milkers in India, provided very good working bullocks. Crossing with English cattle had been tried and some success attained. The production of a "dual purpose" animal would be the economic solution of the difficulties of breeding bullocks. First crosses had given twice as much milk as the Indian parent and the bullocks had sold for twice the ordinary price.

In reply to Mr. Chadwick he said cross-bred cattle were more susceptible to disease, but could be protected by preventive inoculation as in China where breeding from foreign cattle and prophylactic measures went hand in hand.

On the question of dairy schools Colonel Hallowes said the Committee were confronted with two problems, the financial and the practical. No definite recommendations were made as to dairy schools as great expenditure would be

involved. Speaking for himself, he thought Military Dairies might assist generally in training dairy students. Amballa and Lucknow might serve the Punjab and the United Provinces and there were dairies at Ahmedabad and Poona in the Bombay Presidency, Ruk (in Sind), Quetta (in Baluchistan), Jubbulpur (Central Provinces) and Bangalore (Southern India).

As to practical difficulties, schools would have to be large and to deal with produce on a wholesale basis as in the Military Dairies. If after obtaining assistance of the Military Dairies at the beginning the Agricultural Departments afterwards started their own schools, they would do so with some experience.

As regards transport, the Great Indian Peninsula and Bombay, Baroda and Central India Railways had met the Military authorities in a generous spirit.

In connection with paragraph 4, Mr. Meggitt enquired whether cheese had been manufactured at any dairy farm. Mr. Smith said Mr. Keventer had, for many years, made tiffin cheese from buffaloes' milk and mentioned pressed curdled milk which was largely consumed and of which the production might be greatly improved. Separated milk was now thrown away at the rate of 13 to 15 tons daily at Ahmedabad.

The Hon'ble Mr. Swamikannu Pillai proposed an amendment of paragraph 5 which was accepted and paragraphs 5, 6 and 7 were passed without further discussion.

Mr. Wood referred to the heavy loss due to the importation into large towns of the best milking animals which were not subsequently bred from. Mr. Smart and Mr. Hamilton confirmed this from their experience particularly as regards buffaloes. Mr. Smith said this drain was most serious but pointed out that the Committee's recommendation dealt with this in a general way ; if the problem of city milk supply could be solved by the importation of milk from outside and the elimination of milk producing animals from urban areas, the drain would cease.

The President proposed and Dr. Leather seconded **the following resolution :** adopting the amended report as given below :—

" The Board accept the general principles enunciated in the report of the Committee on the Dairy Industry in India and desire to emphasise the importance of a satisfactory solution of the problem of the milk supply of towns, not only in itself, but from the point of view of stopping the drain of good milch cows and buffaloes to the towns where they are not utilised for breeding purposes to the best advantage. The Board consider that some legislation is necessary." This resolution **was passed unanimously.** RE

At the conclusion of the discussion, the President thanked Colonel Hallowes for his very valuable assistance in dealing with the subject and for his sympathetic suggestions with reference to dairy schools.

Report of the Committee.

44. The condition of the dairying industry in India is admitted on all hands to be most unsatisfactory although Indian conditions offer a field for the development of dairying second to none in the world. Dairy produce is one of the staple foods of the people and cattle in India are bred almost exclusively for milk and draught purposes. Again Dairying is a branch of Agriculture which can be very successfully combined with cropping and is also specially suited for the development of the co-operative idea. In order that steps may be taken to improve the condition of the industry, the Committee make the following recommendations :—

(1) That Dairying as a branch of Agricultural Science should, in future, occupy a prominent place in the programmes of the Agricultural Departments.

(2) That legislative measures against the adulteration of milk should be taken to protect honest traders, and the public and to encourage capitalists and Co-operative Societies to invest money in the Dairy Industry.

(3) That sustained and systematic effort should be directed towards the improvement of the milk producing qualities of dairy cattle, both cows and buffaloes. The Committee are of opinion in this connection that there is no necessary conflict between draught and dairy qualities in cattle. It is therefore recommended that efforts should be directed to breeding what is known as the dual purpose animal. With a view to this end the Committee recommend :—

(a) That cattle breeding farms at suitable centres should be started with a view to increase the milking capacity of dairy cattle by selection and judicious crossing. Special attention should be paid to experimental feeding for the purpose of ascertaining what are the best fodder and food stuffs for dairy cattle. A dairy school should be opened in each province at some important dairy centre for the training of persons who propose to engage in dairying.

(b) That the supply of bulls on the premium system or otherwise to villages should be encouraged.

(c) That cultivators should be encouraged to grow crops which are specially fodder crops and the distribution of free seed for this purpose should be considered.

(d) That effort should be directed to educating the people on the practical side of cattle management and in particular to the profitableness of the dual purpose animal.

(e) That the question should be considered of establishing in the better cattle breeding districts milk record societies on the lines of the Danish "control" bodies in order that *the selection of bulls of known quality may be made with certainty* and the uselessness of inferior cows brought home to the breeder.

(4) With a view to the spreading of information as to the best means of handling, storing, transporting and selling milk and the manufacture, packing, transit and sale of milk products, the following measures are recommended :—

(a) The dissemination by practical demonstration of the most up-to-date and profitable methods of pasteurising and sterilising milk, of transporting and distributing milk in suitable vessels, of the manufacture, storage, packing, and transport of *ghee*, butter and cheese and the utilisation of separated milk and other by-products. It appears that in many of the milk producing districts where separators are used, the separated milk is thrown away at present.

(b) The education of public opinion in cities, as to the importance of a "clean" milk supply, by means of the Press.

(c) The provision by Government of free information and assistance to any one willing to embark on a dairy enterprise of any sort. This should take the form of free plans and specifications for all classes of dairy buildings, free specifications and advice as to the purchase and erection of plant, advice as to correct systems of keeping dairying accounts and free information generally on all points connected with the establishment and working of dairy enterprise in any direction, so that any one willing to invest money in the industry might be so guided as to ensure his organisation being planned in the best possible manner for profit earning.

(5) The Committee further recommend the taking up by co-operative societies, public companies or private individuals of the business of production or sale of milk, the manufacture and distribution of milk products and kindred objects. It is understood that it would be quite practicable for co-operative societies to raise loans secured on the capital assets of the concerns.

(6) The Committee further recommend that cheap rates for the carriage of dairy produce by passenger and mail trains should be granted. It appears that Indian Railway rates for milk are at present 100 per cent. over British charges for distances over 50 miles.

(7) As regards scientific investigation, the Committee recommend that steps should be taken to find out—

(a) How best to sterilise milk in India.
(b) How to make a good starter for ripening buffalo cream.
(c) What percentage of fat buffalo cream should contain to produce the best results in ripening.

The following is a summary of the recommendations of the Committee :—

(a) Legislation to protect honest trading.
(b) Cattle breeding at Government Farms or at private farms under Government supervision with the object of producing an improved type of dual purpose animal.
(c) Distribution of bulls to villages on the premium system or otherwise.
(d) Encouragement of the growth of crops which are specially fodder crops.
(e) The establishment of milk record societies in the better cattle breeding districts.
(f) Spread of knowledge of improved methods.
(g) The establishment of a properly equipped Dairy School in each province.
(h) The organisation and, if necessary, the subsidising of dairy concerns especially on co-operative lines.
(i) The giving of advice to private individuals for the purpose of starting or managing a dairy business.
(k) Cheapening of the means of transport by rail for dairy produce.
(l) *Scientific investigation.*

The extra establishment necessary to carry out the above programme, if approved, must be worked out for the special conditions of each province.

45. The Hon'ble Sir Robert Carlyle then addressed the Board. He said :—

"I feel that it has been a great privilege to have been able to attend some of your meetings, and I only regret I was unable to be present throughout. A good deal of what I had in mind to say has already been well put to you by Mr. Mackenna and by Dr. Mann in the report of his Committee and in his speech ; but the matter is so important that I will venture again to address you on the subject of the close connection which ought to exist between the co-operative movement and the progress of Agriculture.

"Looking back on the state of things in this country when Lord Curzon started the Agricultural Department in its present form, the progress made is remarkable. Work of great value has been done on some of the most important crops grown in India, and we are already beginning to see the results. The Department has in many places got into close touch with the cultivator, and has succeeded in inducing him to look to it for guidance and help. Great as has been the advance already made, we are only at the commencement, and if progress is to be as rapid and as secure as we all desire, we must work in close touch with the co-operative movement. The two Departments must join forces to obtain the best results. In the

case of the Co-operative Department union is necessary to enable co-operation to rise to the height of its great task of raising the economic status of the people; and in the case of the Agricultural Department, it will, unaided, make comparatively slow and halting work in its propaganda of agricultural improvements. While I would welcome, as time goes on, a large increase in the personnel of the Department, and while I have no doubt many Local Governments will very soon require considerable additions to their agricultural staff, it is obviously desirable to make any staff appointed by Government go as far as possible. Co-operative Societies should afford us an admirable non-official agency which could be guided on right lines by a comparatively small supervising staff. The primary object of the Agricultural Department is to enable the cultivator to produce larger or more profitable crops. There are many different ways in which this object has to be pursued, but one of the most important means of bringing about the desired result is to establish numerous seed farms for the production of improved seed. For this purpose co-operative societies would seem to be well adapted. Independently, moreover, of the work done in direct co-operation with the Agricultural Department, there are other directions in which co-operation has to supplement the work of the Department. For instance, it is not always enough to teach the agriculturist the use of new or improved implements or the value of manures for his land, but we have to help him to get what is wanted as cheaply as possible. Then again we would often find it very important to help the cultivator to get the best price for his produce. All this requires the help of the Co-operative Department. In this connection I would add one word of warning, and that is that co-operative Societies should not be used for experimental purposes, and the functions allotted to them in connection with agriculture should be of a very strictly defined character. This is essential, as it is of the greatest importance that all the book-keeping of village co-operative societies should be of the simplest character possible. In time as education improves, this may become less important, but at the outset it is a matter which appears to me of great consequence.

"Gentlemen, I have had my say on a matter I believe to be of vital importance to the progress of agriculture in this country, and I will not detain you any longer. I have had the advantage of being present at the very important discussions regarding agricultural education and dairying in India. I have only had time to glance at the reports of the various Committees, but I have seen enough to satisfy me that solid and important work has been done at this meeting of the Board of Agriculture, and I can assure the Board that all their proceedings will be most carefully considered. In conclusion, I congratulate you all on the great success of the Eighth Meeting of the Board of Agriculture."

This address was received with applause and was followed by votes of thanks to Sir Robert Carlyle, Sir John Atkinson, Sir Alfred Bourne and the President.

46. In view of the probability that this would be the last meeting of the Board at which the present Superintendent of the Agricultural Adviser's office would assist, the following address drawn up by Mr. Clouston and supported by the President was presented to the Rao Saheb with the undivided approval of all the members of Board.

"Before we break up I should like to dwell for one minute on the fact that before this Board meets again Rao Saheb Nagarji who has so ably attended to the heavy clerical work of the Board—a formidable task in itself—will have retired from Government service. He has already put in 32 years. At our Conference he has been with us from the beginning and has, by his exceptionally able management of his duties, made the work of the President much easier than it otherwise would have been. He is a man of ability and tact. His staff willingly do their best for him and the work is well done; and no friction ever arises in his office.

"We have tried his patience on many occasions at these Board Meetings by demanding that our lengthy committee reports handed over to him late in the evening should be ready for distribution the following morning. On such occasions he has always risen to the occasion and to cope with the work he and his staff have occassionally had to work night and day.

"He has earned the good opinion of all the officers under whom he has served. He has had the title of Rao Saheb conferred on him by Government. I ask you all to unite with me in showing our appreciation of his services by recording this minute in the Report of the Board's Proceeding."

APPENDIX—A.

Subject 11.—Programme of the Imperial Department of Agriculture for 1914-15.

I.—AGRICULTURAL CHEMISTRY.

(J. Walter Leather, V.D., Ph. D., F.I.C., F.C.S.)

Major Subjects.

1. Investigation of the availability of plant food in soils will be continued.

2. Experiments on possible improvements in the refining of saltpetre will be continued.

3. The variations of certain physical and chemical properties of individual seeds of the same plant is being examined.

4. The records of the amount and nature of drainage water from fallow land and from land under crops are maintained.

Minor Subjects.

5. An attempt is being made to ascertain the nature of the hydration of clay in soils.

6. The permeability of soils to water is being studied.

7. The relation of moisture in cereal grains to weevil attacks and the manner of absorption of certain insecticides is being examined in collaboration with the Imperial Entomologist.

Education.—This requires no special comment and will be conducted according to the lines laid down.

II.—ECONOMIC BOTANY.

(A. Howard, M.A., A.R.C.S., F.L.S.)

1. *Training.*—The training of advanced students in this section will be continued.

2. *Plant-breeding and plant improvement.*—During the year the following crops will be studied :—wheat, tobacco, oil-seeds and fibre plants

(a) *Wheat.*—The production of improved and rust-resistant types by selection and hybridisation will be continued. The co-operative experiments on the influence of the environment on the milling and baking qualities of Indian wheats, which are being conducted in collaboration with Mr. H. Martin Leake, Economic Botanist to the Government of the United Provinces, will be continued. The botanical survey of the wheats of Baluchistan and the agricultural survey of the wheats of Bengal will be completed.

(b) *Tobacco.*—The production of new varieties by selection and hybridisation will be continued, as well as the testing and curing of the varieties already isolated. The detailed study of the inheritance of characters in tobacco is being continued by the Personal Assistant.

(c) *Oil-seeds.*—The study of the oil-seeds of India will be continued on similar lines to those adopted in the investigations on wheat.

(d) *Fibres.*—The isolation and testing of pure races of the fibre plants of India will be continued. The study of the inheritance of characters in these crops is being continued.

(e) *Fruit.*—The fruit experiment at Pusa will be continued on the lines laid down in the First Fruit Report. During the months May to September the work connected with the development of the fruit industry of Baluchistan will be continued.

III.—MYCOLOGY.

(E. J. Butler, M.B., F.L.S.)

I. *Research and experimental work.*—The investigation of some diseases of rice will be continued. The present stage of the investigations is given in Pusa Bulletin No. 34 (Diseases of Rice) and Memoir, Botanical Series, VI, No. 2 (A Sclerotial Disease of Rice). The work will be continued particularly with a view to filling up gaps in our knowledge of the life history of the organism which causes *ufra* disease, to the explanation of the apparent immunity of transplanted paddy to this disease, and to testing methods for its control. This will be for the present considered the most important item of work of the section. With regard to the other diseases of rice, none appear at present to be of great practical importance, and the investigations will be confined chiefly to the life history of the parasites concerned.

The investigation of the fungus diseases of sugarcane will be continued. Two Memoirs, containing the results of the work up-to-date, have recently been submitted for publication and deal with the methods of infection and control in red rot of sugarcane, and with the symptoms and cause of three undescribed cane diseases, two of which have been sometimes confused with red rot. Future work will include a more detailed study of one of these diseases (collar rot) and its connection, if any, with the *sereh*-like degeneration of cane known in several parts of India. The extent to which soil infection occurs in red rot will also be studied.

The study of the wilt diseases of cotton and sesamum will be continued on the lines described in Memoir, Botanical Series, II, No. 9 (Wilt disease of Pigeon pea). No results of interest have yet been gained in connection with these diseases, which are of sufficient importance to be considered as amongst the major diseases of crops in India.

The work on potato blight recently commenced may also require to be treated as a major investigation, if the disease recurs in the Gangetic Plain, where there was a severe outbreak last year. It is hoped to study the growth of the parasite in artificial culture and in particular to investigate its temperature relations as it is in this direction that its control appears to be most hopeful. As minor investigations the study of some allied parasites will be undertaken. Two of these have been studied in detail and the results published as Memoirs, Botanical Series, V, Nos. 4 and 5 since the submission of the last programme to the Board.

The opium poppy blight has usually been believed to be caused by a fungus allied to the last mentioned group, but evidence was obtained last year, when the disease was severe, which suggests that this is not the case, but that the cause is a species of *Rhizoctonia*. The investigation of this disease may become of importance if another severe outbreak occurs. It will be directed to ascertain the true cause and to test methods of control. The study of other diseases caused by *Rhizoctonia* will be continued as occasion arises, but none appear at present to require detailed investigation of the methods of control. An account of the scientific work on *Rhizoctonia* since the submission of the last programme, was published as Memoir, Botanical Series, IV, No. 6.

The study of certain green parasites of crops will be continued. Little is known of these parasites in India and it is of importance to investigate their biology, particularly with reference to possibilities of checking the damage caused by them. The investigation has only recently been commenced and has not yet given any definite results.

Some preliminary work on soil fungi has been commenced and it is hoped to develop this as time permits particularly with a view to elucidate the action of fungi in assisting in the decomposition of organic matter. The subject may prove of interest in connection with green manuring, but it is not possible, as yet, to indicate on what lines it will develop.

A number of minor investigations of diseases of crops and forest trees are in progress or projected. New work of this nature continually arises and it depends on the time available for their study and the relative importance of the disease as to whether they become major or minor items of the work of the section.

II. *Training.*—This will be continued on the lines indicated in the Prospectus. Short courses will also be given if any students of the Institute wish to attend.

III. The routine work of advising on plant diseases will be continued, and assistance will be given as usual to Provincial Departments of Agriculture, the Forest Department, Planters' Associations and the general public.

IV. It is hoped to make further progress with the publication of descriptive lists of Indian fungi in the series "Fungi Indiæ Orientalis," of which four parts have already been published in collaboration with Messrs. H. and P. Sydow of Berlin. The extension of this series to include the groups not yet dealt with is the most important part of the systematic work of the section and is very necessary. Minor papers on systematic mycology will also probably be published.

IV.—ENTOMOLOGY.

(A. J. Grove, M.Sc.)

Crop Pests.—The work of investigating and advising upon insect pests of crops will be continued and accounts of life-histories, etc., will be published as material accumulates.

Lac.—The cultivation of Lac for demonstration purposes will be continued.

Silk.—Both Eri and Mulberry worms will be reared as usual and breeding experiments continued.

Apiculture.—Experiments with European and Indian bees will be continued.

Training.—Students will be admitted for the long course in general Entomology and the short courses in Sericulture and Lac cultivation will also be given as usual.

Insecticides.—As formerly samples of new insecticides sent in for trial will be tested and reported upon, and experiments made, as opportunities occur, with various substances which may seem applicable as insecticides.

Other Insect Pests.—Special investigations with insects attacking stored grain, the cotton boll-worm and its parasites, and Termites attacking crops and constructional timber will be carried out.

Coloured Plates and Lantern Slides.—If funds are available then more coloured plates will be prepared. The preparation and issue of lantern slides will be continued as requests are received.

General Work.—The routine work of answering queries regarding insects, the identification of insects, the adding to and arranging of collections and the like will be continued.

New Work.—The issue of a revised edition of "Indian Insect Pests" which is now out of date and has been out of print for years, will be undertaken as early as possible. This implies comparison and checking of all entomological collections and records both at Pusa and in the Province, and will take a considerable amount of time and work. This and the necessary internal reorganisation of the work of the section will probably fully occupy the time of the Imperial Entomologist and will leave the way clear for taking up new lines in future years.

V.—PATHOLOGICAL ENTOMOLOGY.

(F. M. Howlett, B.A.)

The programme of work for 1914-15 will be in accordance with Government orders, and the main lines of enquiry may be expected to be in connection with—

(1) Fruit-flies

(2) Surra-transmitters and parasitic insects.

VI.—AGRICULTURAL BACTERIOLOGY.

(C. M. Hutchinson, B.A.)

General.

1 Elaboration of testing of methods of biological analysis of soils; correlation with field practice with special reference to tillage, drainage, and irrigation

During 1912-13 much work was done on these lines with special reference to conditions under which ammonification and nitrification take place in Indian soils, and the experience gained has made it possible to carry out biological analyses of soils with some reliance in the accuracy of the results; much more work must be done, however, before interpretation of such results can be confidently entered upon.

2. The isolation and characterization of soil organisms with reference to their functions in the soil. This is a very laborious investigation and will continue indefinitely, but in my opinion it is essential that such work should be carried out. Owing to the pressure of other work more obviously connected with field problems, but little progress has been made so far with this line of enquiry, but the relative ammonifying power of certain local soil organisms has been ascertained.

3. *Nitrogen Fixation.*—Work on non-symbiotic nitrogen fixing organisms and their distribution in Indian soils will be continued.

During the past year Mr. Walton has made some observations on physiological activities and distribution of Azotobacter; this work will be continued both with reference to distribution and enquiry as to the most favourable conditions for its normal function.

Special.

4. *Green Manuring.*—This series of experiments in collaboration with the Imperial Agriculturist will be continued. A report on results obtained during the past year is in course of publication as a Bulletin.

5. *Soil toxins.*—Occurrence of toxins in soils and their bearing upon infertility will continue to receive attention. Work on this subject so far has demonstrated the undoubted presence of toxic bodies in all soils examined at Pusa; the relation between their formation and the condition of the organic matter in the soil appears to be a question of primary importance and will continue to form an item in the work of this section.

Subsidiary investigations.—These will include such enquiries as may be necessary in connection with plant pathology, diseases of silk worms and other subjects requiring bacteriological investigation.

VII.—AGRICULTURE.

(S. MILLIGAN, M.A., B.Sc.)

Since the last programme of this section was presented to the Board in 1912 the appointment of the post of Imperial Agriculturist has been revived.

General Estate Management.—The low lying area at Pusa to the west of the Waini road has been practically all reclaimed. This work will be finished early in 1914.

The drainage of the Estate has been improved and by the addition of a pumping station, it is hoped, that the whole area will now be secured against flooding.

Steam ploughing tackle is being introduced in order to promote greater efficiency in the supervision of experimental work.

Field Experiments.—An additional area of 22 acres has been levelled and prepared for plot experiments.

Permanent Manurial and Rotation Experiments.—These experiments will be continued. In the low lying area gram (*Cicer arietinum*) will be substituted for Arhar (*Cajanus indicus*) in the leguminous rotation on account of the unsuitability of the latter for this class of land.

To the green manuring series a plot has been added in which superphosphate is applied to the green manure.

Field experiments on green manuring in collaboration with the Imperial Agricultural Bacteriologist have been going on for two seasons and will be continued.

It is proposed to study the effects on the *rabi* cereal crops of the time of application of manures.

It is proposed to make a special study of various methods of conducting plot experiments with the object of obtaining more reliable results therefrom.

Experimental cultivation.—A considerable amount of work has been done with reference to the improvement in the cultivation of maize and sugarcane by improved tillage methods. This work is expected to be finished in 1914. New methods of dealing with the cultivation of heavy soils (for ordinary cultivation as opposed to rice growing) are in progress. The results so far indicate a great superiority of revolving harrows and sectional rollers over other implements.

Pasture.—Various methods of laying out land to pasture are under trial.

Considerable improvements have been obtained by topping and harrowing the Pusa permanent pastures.

Breeding Herd.—Some improvement in the average milk yield has been obtained through a more rigid selection of the cows. Selective breeding will be continued.

Dairying.—The question of the establishment of a Dairy at Pusa is under consideration.

Sheep Breeding.—Experiments in crossing Gorakhpur ewes with Dumba rams have been in progress for some years but have suffered through want of a definite objective. The improvement of wool will now be the chief object in view combined with suitability to local conditions.

VIII.—COTTON.

(G. A. GAMMIE, F.L.S.)

1. To visit and advise on points regarding cotton and its cultivation whenever requested to do so by Provincial Departments of Agriculture.

2. The study of the behaviour of Bourbon, Buri, Cambodia and other such cottons in non-cotton producing tracts, as detailed in the last year's programme, will be continued.

3. An enquiry on the manurial requirements of cotton will be continued.

4. Researches on the botany of cotton will be continued.

PROGRAMME OF WORK OF THE IMPERIAL BACTERIOLOGICAL LABORATORY AT MUKTESAR FOR 1914-15.

VETERINARY.

(MAJOR J. D. E. HOLMES, M.R.C.V.S., M.A., D.SC.)

(i) *Rinderpest.*—To continue an investigation on the influence of drugs administered by mouth and subcutaneously in the course of the disease, the object being to discover a method of treatment for Rinderpest. The Rinderpest Anti-Serum is a prophylactic agent and of very little curative value. Consequently, there is no known means of saving the lives of animals when once infected with Rinderpest.

The discovery of an effective treatment for Rinderpest would be of great economic importance. All experiments on this line have up to the present given negative results.

(ii) *Anthrax.*—To continue the investigation on methods of prophylaxis and treatment, a paper on the parctical value of Anthrax Anti-Serum and Vaccines (preliminary report) has recently been published.

During the past year further work on the value of the combined use of Anti-Serum and Virus and of Anti-Serum and Vaccines has been carried out.

(iii) *Hæmorrhagic Septicæmia.*—An investigation of the drug treatment for this disease on the same lines as is being carried out for inderpest.

(iv) *Kumri.*—An investigation into the etiology of the disease. All work on this subject has up to the present given negative results. The further investigation must be carried out at the seat of outbreaks. This depends on the appointment of a Pathologist.

(v) *Bursati.*—To continue the investigation into the etiology of Bursati. Certain results have been arrived at, but require confirmation.

APPENDIX—B.

Subject III.—Programmes of the Provincial Agricultural and Veterinary Departments and of Native States Departments Agriculture for 1914-15.

1. BENGAL.

I.—GENERAL REVIEW OF CHIEF ITEMS.

(J. R. BLACKWOOD, M.A., I.C.S., *Director of Agriculture.*)

I. *Sericulture.*—*A scheme has been initiated for* supplying seed free from disease to the whole province. Research work will also be carried on with a view to the production of a class of cocoon superior to the native varieties by selection, acclimatization and hybridization.

II. *Pisciculture.*—Efforts will be directed to finding out why carp fail to breed in confined waters in India and where the spawning grounds of the *hilsa* are located. Demonstrations in fish-curing will be carried out as far as possible.

III. *Farms.*—A scheme has been initiated for improving the breed of indigenous cattle by selection and also for demonstrating the financial possibilities of mixed farming. A considerable quantity of superior jute seed will be grown and distributed to cultivators as well as sugarcane cuttings of superior varieties. An attempt will be made to show that tobacco can be grown and *flue-cured* at a profit. The experiments at the Dacca farm with a view to evolving superior varieties of jute, paddy, oilseeds, pulses and chillies by selection and cross fertilization will be continued.

IV. *Demonstration.*—A new scheme has been sanctioned by Government for increasing the number of Government demonstrators from 8 to 30. These demonstrators will be in charge of a certain number of plots for which they will be responsible : but in addition they will assist in working out a scheme for demonstrating agricultural *improvements through the agency of zemindars. A beginning* has been made in the district of Mymensingh, where the zemindars of that district have agreed to advance money for purchasing such manures, seeds or implements as are required for the purpose of demonstration and subsequently recovering the money from the ryots. It is hoped that this example will be followed in other districts.

V. The scheme for the improvement of the jute forecast by taking a census of jute fields by the agency of *panchayats* will be developed and improved in the course of the year.

II.—AGRICULTURE.

(F. SMITH, B.Sc., F.H.A.S.)

Main lines of work.—The most important point on the working of Bengal demonstration farms is to see that the results obtained are relative to the ordinary expenditure incurred. Great improvement in this respect has been made during the last year, but much remains still to be done. This will receive careful consideration.

Experimental work is so subject to error on account of variations of rainfall and floods, that I believe that small plot results are entirely misleading and should not be acted upon till we have corroborated the results further on—at least acre blocks for a few years. This is receiving careful attention. The main work at each farm is restricted *to one crop. Seed of these crops is selected and grown for distribution*, and in addition to which there is a seed store at each farm for distribution of seed, manure and implements. The following table shows the present stations under my control with the district wherein situated, the kind of soil or tract represented, the average rainfall recorded, the area of each station, the main line of investigation and the secondary work that is being carried on :—

NAME OF STATION.	District in which situated.	Kind of soil or tract.	Average rainfall in inches.	Area in acres.	Main line of investigation.	Secondary work.
Dacca . .	Dacca . .	Laterite . . .	72	353	Rice (autumn and winter).	Sugarcane, jute and high-land improvement.
Chinsurah .	Hooghly .	Lower Bengal Delta .	58	202	Rice (winter) . .	Jute and irrigation for *rabi* crops.
Burirhat . .	Rangpur .	Tobacco tract . .	84	52	Tobacco (growing and curing).	Soil improvement.
Rajshahi . .	Rajshahi .	Gangetic alluvium (marl).	56¼	63	Sugarcane . .	Jute and potatoes.
Burdwan . .	Burdwan .	Laterite . . .	57¼	31	Demonstration.	
Rangpur . .	Rangpur .	Rice and jute tract (sandy).	84	20	Ditto.	
Kalimpong .	Darjeeling .	Himalayan tract .	89¼	61	Maize and rice . .	Pine-apples, fruit, buck-wheat and *kodo*.

In 1914-15 another divisional agricultural station of 60 acres for the Chittagong Division will be opened and laid out at Brahmanbaria, near the Megna in the Tipperah district. The main line of work on this station will be jute. Bearing in mind that the laterite area requires particular attention as regards lime, phosphoric acid and organic matter (Chinsurah, as regards water control ; Burirhat, heavy manuring ; and Rajshahi, organic matter, phosphates and potash), the following general scheme will be adhered to :—

Rice—1. Manures.

2. Varieties.

3. Methods of cultivation—

(*a*) Seedlings—number and distance apart.

(*b*) *Seed beds—seed rate.*

(*c*) Rotations.

(*d*) Ploughs.

(*e*) *Time of ploughing.*

Jute—1. Manures.

2. Varieties.

3. Methods of cultivation—

(*a*) Ploughs.

(*b*) Rotations.

4. Steeping—kind of water.

Sugarcane—1. Manures.

2. Varieties.

3. Methods of cultivation.

Maize—1. Manures.

2. Varieties.

3. Methods of cultivation.

For details see below.

With slight modifications as time and experience may show to be necessary, this programme will be adhered to for the next 10 years.

Young men will be trained practically at all the farms.

Dacca.—The chief work of past years will be continued, and the most economical manures and methods of cultivation for autumn and winter transplanted rices for this tract of land will be further studied. The good work of growing thick canes will be continued on a larger area, and more cane will be grown for distribution purposes. An attempt will be made to grow jute economically, and efforts will be made to find an economical *rabi* crop that will suit this class of soil.

Further trials will be made with agricultural implements, and another batch of apprentices will be trained in practical agriculture.

All the help that the Agricultural Chemist and Economic Botanist require on the farm will be given.

Chinsurah.—The chief work at this station will consist of laying out the farm to allow of irrigation to assure the paddy crop and of producing a large supply of good jute seed for distribution. Apprentices will be trained in practical agriculture.

Rajshahi.—The chief work will consist of producing a large quantity of jute seed and thick cane for distribution purposes. Apprentices will be trained in practical agriculture.

Burirhat.—The work of growing (with flue curing and shade curing of) Sumatra, Virginian and Turkish tobaccos will be enlarged and continued, and an attempt will be made to produce a larger quantity of cured tobacco for sale as well as a larger quantity of tobacco per acre.

Men will be trained practically in the above work.

Kalimpong.—The good work of seed selection on maize will be continued, while attempts will be made to increase the outturn of rice per acre.

Burdwan and Rangpur Demonstration Farms.—These two farms will be run as demonstration areas. They will also serve as centres of distribution for seeds, manures and implements—

Demonstration.—As at present arranged this work is in the hands of the Director of Agriculture. Deputy Director advises when required.

Shows.—This work of demonstrating the work of the Agricultural Department will be continued and enlarged as far as the energy and desire of local people permit.

Seed depôts.—The depôts for seed, manures and implements at Sibpur, Dacca and all the farms will be continued under the control of the Deputy Director. Selected seeds, manures and implements will be stocked, so that there will be no delay in local people procuring their requirements.

III.—ECONOMIC BOTANY.

(G. P. Hector, M.A., B. Sc.)

1. Rice.

Main investigations.—(*a*) The survey, classification and selection of the transplanted *aman* and *aus* rices of the province will be continued. Trial on a practical scale of promising types already selected will be carried on both on the farms and in districts against local varieties. This work has gone on now for three seasons, and up to date about 150 varieties have been studied in detail in pure line cultures, and a classification based on morphological and field characters is being made. In particular the extent to which natural cross-fertilisation takes place has been studied, and this work will be continued. Special attention is being paid to high-yielding types, and some of the best of these are now being tested on a practical scale.

(*b*) Cross-fertilisation experiments with the object of determining the mode of inheritance of certain of the more important differentiating characters have been commenced and will be continued.

Subsidiary investigations.—(*c*) In conjunction with the Agricultural Chemist, the question of how far the composition of the grain is correlated with morphological and field characters will be studied. This work has been commenced, and results so far obtained appear to indicate that the early maturing types which generally have small hard, translucent grains are comparatively poor in starch, while the late maturing types, which generally have larger, softer and more opaque grains, are richer in starch.

(*d*) Experiments, already commenced, in the selection of seed, particularly of *aus* paddy, by the specific gravity method, will be continued, with the object of determining whether this is likely to prove an effective and economic method for the raiyat to adopt. This experiment has been carried on only one year, and results appear to indicate that the plots sown with heavy, selected seed at a much smaller seed rate (on an average ⅓rd the ordinary local rate, with a saturated salt solution) give a yield at least equal to those sown with unselected seed at the ordinary seed rate.

(*e*) Experiments, already commenced on lines recommended by the Imperial Mycologist, with the object of determining some effective and economic method of checking *Ufra* disease of rice, will be continued (this work will probably be taken over by the Deputy Director of Agriculture).

2. *Other crops.*

Main investigations.—(*a*) The survey, classification and selection of some other staple crops of the province chiefly *Brassica Spp.*, *Sesamum Spp.*, *Phaseolus Spp.* and *Capsicum Spp.*, will be continued. The main varieties and types of each of these crops have already been isolated and will be grown for observation, and seed of the best multiplied for comparative trials.

Subsidiary investigations.—(*b*) Some experiments in green manuring will be continued, particularly with a view to determine how far it is possible to grow catch green manure crops on high land between early paddy and the subsequent *rabi* crop, in order to obviate the loss of a crop. This has already been proved to be possible on the Dacca farm, and the work will be continued. This work is being carried on in conjunction with the Agricultural Chemist.

(*c*) In conjunction with the Fibre Expert, cross-fertilisation experiments in jute, with the object of determining whether it is possible to combine the long ultimate-fibre length, which is one of the main factors on which quality depends, characteristic of certain varieties, with the high-yielding capacity of certain other varieties, will probably be commenced.

3. The fruit experiments will be continued. The object of these experiments is to determine what varieties can be grown successfully in Dacca district, and under what treatment. Special attention will be paid to mangoes, lichees, guavas, custard apples, plantains and pine-apples.

4. The Mycological and Entomological Collectors will continue to work under the Economic Botanist. They are chiefly employed in collecting and identifying the chief fungus and insect pests prevalent in the province, and in demonstrating to the raiyat simple preventive measures.

IV.—AGRICULTURAL CHEMISTRY.

(A. A. Meggitt, B.Sc.)

The main work which is occupying the attention at present may be put under three broad heads :—

I. Sugarcane work.

II. Soil investigations in the Laboratory, involving experimental field work at different centres.

III. Green-manuring problems.

The first two will continue during the coming year as major work, while the third having been well advanced will form a subsidiary line of investigation.

I.—Sugarcane.

Work on this crop in collaboration with the Deputy Director of Agriculture, Assam, will be continued and extended. Up to the present the work has been chiefly varietal, involving a large amount of chemical control.

Two Barbados canes of great merit have been acclimatized and are being distributed.

These varieties easily yield from 25—30 tons of cane per acre, with a juice containing 16—18 per cent. sucrose, and having a very low glucose ratio and a purity co-efficient of over 90 per cent.

This variety work will be continued and extended, new varieties being imported from time to time against possible deterioration ; four new varieties have been recently indented for from the West Indies.

Work on planting methods, manuring, and the best rotation of cropping is also in hand and will be extended. In our efforts to obtain big yields of high quality cane, there can be no doubt that there exists a very close mutual relationship between these three problems of planting methods, manuring, and the rotation of crops, while for cultivation on a large scale for Central Factory work, such as we are aiming at in Assam, the extensive nature of the tillage operations required must also be considered in regard to methods of planting.

Rotation.—A rotation of two years' cane, followed by *aus* paddy and *matikalai* in the third, with a green crop of cowpeas in the fourth year preparatory to cane again, has proved very successful, and the effect on the soil and the cane crop of the inclusion of cowpea as a green-manure has been especially marked and beneficial, deepening and enriching the soil and increasing the outturn of cane.

Planting.—The planting experiments so far tend to show that wider planting between rows increases the tillering power of the cane, and that having regard to yield and quality, for high class thick canes in Assam, the optimum number of sets per acre is of the order of 7,000.

Manurial.—Manurial experiments in relation to the phosphatic requirements of cane on these soils, and in regard to the relative value of cowdung and oil cake, are in progress. This work will be extended as opportunity permits.

Moth borer.—To minimise the attacks of moth borer, the experiment of burning the trash in site on the cane field after harvesting was tried last year, and whether the result is to be wholly ascribed to this burning or not, the fact remains that the incidence of attack by borer was very much reduced indeed this year, even in certain soft varieties which are especially subject to attack. Another noticeable effect was the improved tillering of the following ratoon crop. This practice will be continued.

II.—Soil Investigations.

This work, which has been engaging attention for the past three years, is a general investigation of special soil conditions obtaining in North-East India in tracts of heavy rainfall, where a dangerous degree of soil acidity is fairly general.

Hand in hand with laboratory work, field work is being carried on at several centres. Much valuable information has already been obtained as to the special characteristics of these soils, and the measures adopted for their amelioration are proving very promising. The work is being tackled principally from the point of view of the soils' requirements for lime, phosphoric acid and organic matter, and involves a study of the principles underlying their most successful and economical use and supply.

Of special importance under our conditions is the form in which certain manures find their most suitable application.

Thus work at Jorhat and Dacca has shown that the use of the bone-meal and basic insoluble phosphates is generally attended by markedly beneficial results on cropping, while where phosphoric acid is applied as acid superphosphate the effect is practically *nil* unless used in conjunction with lime.

At Jorhat again, sulphate of ammonia has proved definitely toxic to a *rabi* crop of oats, except where the soil had received a previous liming.

Field work.—The field experiments lain down on the above lines at Dacca and Jorhat in 1911 to run at least six years, are now in their third year, and are already showing most interesting and valuable results.

Dacca experiments.—On the stiff red acid soil at Dacca the use of lime and bone-meal has had a remarkable effect, particularly on *rabi* cropping. While *aus* paddy in the rains had responded very little, the other crops in the

rotation, *i.e.*, *dhaincha*, mustard and *matikalai* have responded liberally to the use of lime alone, and also bone-meal alone, but the effect of the two applied together is especially marked, very considerable profit per acre accruing from moderate lime dressings, cross-dressed with bone-meal. *Dhaincha* as green-manure has not shown up to date any very marked action, as unfortunately the weather prevented its being ploughed in until it became too woody.

Jorhat Experiments.—On the lighter but more acid soil at Jorhat the early action of lime alone is so strongly marked that it largely masks the effects of other manures.

Except on the mustard crop, bone-meal has not shown nearly such positive action as at Dacca, while the effect of green-manuring is very much greater indeed. This is probably due to the lighter nature of the soil, and also to the fact that cowpea was the green-manure used.

Here, as at Dacca, while the indications from the *aus* paddy crop are small, the other crops in the rotation, *viz.*, cowpea, jowar, oats and mustard have provided the most convincing evidence of the great value of lime on this soil.

The effect of lime on oats and jowar became greater with increasing dressings, no crop at all being produced in its entire absence. In the case of mustard the smaller lime dressings were almost as effective as the larger ones, full crops maturing only when cross-dressed with bone-meal.

Even with mustard, however, the use of bone-meal without any lime resulted in no crop whatsoever. It is significant to note that at Jorhat the plots which have received no lime, even when cross-dressed with bones and cowdung, have produced no crops whatsoever, barring *aus* paddy, since the experiment was commenced.

Despite the high cost of lime in Assam, the moderate lime dressings are showing fair profits, especially where green manure is included in the rotation.

One other point which it is desired to make concerns the relative efficiency of large *versus* repeated smaller lime dressings, but the experiments are too young to offer any opinion as yet.

New field work.—The success which has attended the use of lime and insoluble phosphates on these acid soils has led to various new lines of work as follows :—

(*a*) the testing of raw finely ground mineral phosphates as substitutes for the more expensive bone-meal.

Laboratory tests are being made in conjunction with field and pot work.

(*b*) field experiments in regard to the use of finely ground limestone as a substitute for burnt lime, especially on light soils and where organic matter is very deficient. Results to date show that limestone acts qualitatively like burnt lime, but is slower in action.

(*c*) field work designed to elucidate the reasons underlynig the remarkable action of lime at Jorhat. The first year's results of this experiment are to hand, and though with lapse of time lime does admittedly exercise other effects on the soil, *i.e.*, by improving the texture and the general biological conditions and by liberating plant foods, etc., still results to date prove convincingly that the observed early beneficial action on cropping is undoubtedly primarily due to its power of neutralising soil acids (some of which are highly toxic), thus immediately proving the soil bio-chemical factor.

The above work will be continued and amplified as occasion arises.

Laboratory work in connection with field experiments.—From the purely chemical and physical point of view work is in hand and will be continued in regard to the role of lime and manures used in the field, and their mutual inter-dependence for the best results in practice.

The field plots will provide, as time goes on, suitable material for the study of such problems.

Up to date I have found that the neutralising effect of lime dressings is not exerted to any appreciable extent below the depth to which it is mixed with the soil during cultivation, but that the physical effect of the descending bi-carbonate is marked to a much lower level. These facts have a very evident bearing on the practice of liming.

Again though large dressings of lime of one or two tons per acre cause a very slight increase in the amount of carbonate of lime in the cultivated layer for a few months after application, still 12 months later any excess of calcium carbonate in these plots over that in the non-limed soil could not be detected by the most delicate tests. By this time also the 1-ton lime plot had again become acid, the 2-ton plot beiog still faintly alkaline. These facts shed some light as to the amount of lime that will be required to provide even a small working reserve of carbonate of lime in the cultivated soil.

Further examination showed that the added lime had combined with the acid organic matter of the soil, both neutralising and fixing it, so that whereas before liming the soil gave a dark liquor when shaken with dilute ammonia, after liming it only did so after a preliminary digestion with dilute acid.

The improved cropping power of the soil which accompanies this change in the condition of the organic matter points to this simple ammonia water test as a reliable auxiliary in deciding the necessity for liming and what is a safe amount to apply.

Considered in relation to improved cropping capacity, laboratory tests of the reaction of variously limed plots go to show that while most of the crops grown do best when the soil acidity is fully neutralised, in the case of *aus* paddy acidity as commonly met with seems to have no ill effects.

Work on the effect of lime dressings on the availability of bone-meal in the field (as measured by solubility in 1 per cent. citric acid) so far goes to show that the availability increases with the larger lime applications.

In regard to the effect of manuring on crop composition, the only point clearly established so far is that the phosphoric acid content of the grain of *aus* paddy and mustard is considerably higher on the phosphated plots.

A special line of enquiry has shown that these acid soils may contain a very definitely toxic compound, the Jorhat soil being particularly toxic to jowar in the rains, and many crops in the cold weather. A toxic substance has been isolated from this soil, and experimented with in very dilute culture solution using seedling plants.

Observations thus made agree well with field results ; this substance while very toxic to jowar is not so to *aman* paddy, which, on the contrary, appears rather to flourish in its presence.

The toxicity jowar seedlings in culture solution is very largely minimised by the addition of very small quantities of lime or a complete nutrient solution to the culture. The most marked effects of this toxin are on the young roots, their growth is at once stopped, the root becomes strongly discoloured, generally hooks round and sometimes swells up at the end, the plants succumbing in a short time, while those in control water culture are still alive and growing. The toxin has been crystallised, but not in sufficiently large quantities as yet for positive identification.

Work on the above lines will be continued, and extended to include various other aspects of practical and scientific interest.

III.—Green Crops.

During the past few years several green crops have been under test with a view to discovering those best suited to meet certain conditions, *e.g.*, of soil, period and season of growth, power to resist water-logging, etc.

The following crops have been studied : *dhaincha* (*Sesbania aculeata*), sunn hemp (*Crotalaria juncea*), cowpea (*Vigna catiang*) and matikalai (*Phaseolus radiatus*) the lines of comparison being weight of green matter produced per acre, weight of dry organic matter, nitrogen value per acre, comparative root development, facility of incorporation with the soil, and rate of decay after ploughing in.

Dhaincha.—Results to date show that *dhaincha* if sown early and ploughed in before it gets woody is an excellent green crop, producing large amounts of green matter and nitrogen per acre, and decaying rapidly if ploughed in when some 3 or 4 feet high.

Such a crop will supply upwards of six tons green matter, 60 to 70lbs. nitrogen and one ton or rather more of dry organic matter.

If allowed to get woody, the stalks persist, opening up the soil so that the immediately following crop is not benefited, sometimes the reverse, the effect, however, becoming apparent in later crops. It has a very strong root system, and is better than any other crop tried for opening out stiff sub-soil.

Sunn Hemp.—Sunn hemp does well on light lands, but not so well on stiff damp soils as *dhaincha*. An equal sized crop adds similar amounts of nitrogen and organic matter to the soil, but sunn has the same limitations as *dhaincha* in regard to becoming woody. It does not make such good root development as dhaincha under adverse soil conditions. Decay proceeds rapidly if the crop is ploughed in in good time. Jubbulpur sunn proved superior to the local variety on all counts.

Matikalai.—Matikalai is a useful green crop, slower in growth than cowpea, and does not do so well on poor soils, is apt to become more woody if left and does not decay so rapidly. A good crop will give up to seven tons green matter, 70lbs. nitrogen and over a ton of dry organic matter per acre. It has not such a wide general application in practice as cowpeas.

Cowpeas.—Cowpeas has proved the most generally useful and applicable green crop. Though doing best on light loamy soils, it still makes fairly heavy crops on stiff land.

Sown thickly (25 to 30 seers per acre) on land in fair condition, cowpea will within two months in the rains produce a dense smothering crop, choking weed growth, while the soil surface becomes covered with a mulch of decaying fallen leaves, forming an effective soil mulch some time before the crop is ready for turning in. Except at a very early stage, when all are succulent, the proportion of soft succulent, easily decomposable, vegetation to the whole crop is very much greater in the case of cowpea than with either dhaincha, sunn, or matikalai. The crop decays most rapidly in the soil, a month being usually sufficient if the soil is moist, even for a heavy crop.

Though making good growth on acid soils, it does much better after liming.

The difficulty we have found with this crop is in getting it turned into the land. A rotary "Dix" implement is probably the most useful. On small areas it can be turned in quite easily with the *kodali*.

A good crop supplies some 7 tons green vegetation (containing 0·5 per cent. nitrogen), 80lbs. nitrogen and well over a ton of dry organic matter per acre.

Cowpea has a very wide growing season and may be sown any time after the early spring rains until August with certainty of getting a crop, though the earlier sown crops naturally give the biggest outturn. Late sown crops should be seeded down thickly.

Cowpea is the only green crop it has been found possible in normal seasons to take as a catch-crop on high-land after harvesting *aus* paddy as a preliminary to *rabi* cropping, eight to ten anna crops being possible in this way or within a period of 6 or 8 weeks' growth.

Owing to the long sowing season, rapid growth of the crop, and the relatively large amounts of succulent, easily decomposable, vegetation produced, as also its usefulness as a catch-crop, the cowpea is certainly the most useful green crop tried, and is capable of a much wider application than the others. Its inclusion in the cane rotation at Jorhat has certainly assisted in working an enormous improvement in the soil, which has been clearly reflected in the cane yields.

Future work will include :—

(*a*) The trial of other promising green crops.

(*b*) Further work on the *rationale* of catch green cropping, including the extent of increase in crop production and amelioration of soil conditions which may follow the policy of taking a catch green crop every year, if it is possible.

(*c*) A study of the problem of green manuring in connection with the use of insoluble phosphates ; the most economical way of combining the two.

(*d*) Testing cowpeas as a green manure for lowland paddy.

IV.—Routine work.

V.—FIBRE.

(R. S. Finlow, B.SC., F.C.S.)

1. The experiments with the object of investigating the possibility of the improvement of jute by selection, as indicated in former programmes, have been and will be continued. The following quotation from the annual report of the Fibre Expert for 1911-12 shows the object of this work and the results so far obtained :—

"* * * * * * The work arose naturally out of the preliminary field study of the races of jute in Bengal, undertaken in collaboration with the Reporter on Economic Products to the Government of India. The result of our studies in this latter direction was to place in our hands a number of races varying widely from each other in respect of tallness, colour and time of ripening, cultural characteristics which were used for the purpose of classification. Having proceeded thus far, it was obviously necessary, in order to complete the enquiry, to know whether the various races which our classification had created differed from each other in quality of the fibre they produce, as well as in appearance. Here again considerable differences have been found between race and race ; and as these differences have now persisted through two generations of progeny, there is very little doubt that they are hereditary. The length of the ultimate filament of the fibre of jute does not seem to be associated with tallness or shortness of plants, for very long filament averages have been found to be characteristic of some short races, and on the other hand also of some very tall ones. Similarly both short and tall races appear to exhibit short filament averages. In this position our special attention was given to the tall races, a closer examination of which shewed that individuals in the same race were markedly superior to others in respect of their average filament length. On this basis single plants were selected and in the second generation of the progeny grown in 1911 the filament average was, in some cases, more than 10 per cent. and in one or two cases nearer 20 per cent. better than the average for plots of the same race, the ancestors of the plants in which had not been subjected to selection.

"When the selection work was started, it was thought that it might be possible to correlate the ultimate filament length with the cellulose content of the fibre and, at first, it seemed that such would be the case ; but in more recent observations the figures for cellulose content have not come into line sufficiently well to allow of any definite conclusion being drawn as yet. It is, however, satisfactory to note that the cellulose content of the fibres whose ultimate filaments are largest is certainly not less than in other cases, so that the net result of the whole work, as far as it has gone, is that we are now in possession of one or two races of jute which, while taller than most jutes and at least equal to any

other race in point of vegetative vigour and yielding power, show a decided improvement in at least one phase of the quality of their fibre. Seed of those races is now being multiplied as rapidly as possible for distribution."

2. As a corollary of the above work, cross-fertilisation experiments, with the object of combining the long ultimate fibre-length characteristic of some types with the high-yielding capacity characteristic of certain other types, will probably be commenced.

3. *Manurial experiments.*—With the object of studying the requirements of jute with regard to the various plant food ingredients, will be continued. These were commenced in the season of 1911-12, and while results are not sufficiently far advanced for definite conclusion, they indicate that on the Dacca farm the development of jute is markedly influenced by the application of lime and phosphates to the soil.

4. *Experiments with Sunn Hemp.*—At the Rajshahi farm a collection of varieties of Sunn Hemp from different parts of India are being grown, with the object of comparing them with the local variety. This work will be continued.

5. *Experiments with Sida.*—Field experiments with Sida have been continued during seasons 1911-12 and 1912-13, and yields of fibre at the rate of 12 maunds per acre have been obtained, while a sample of fibre grown on the Dacca farm and forwarded to the Imperial Institute was valued at £30 a ton. These experiments will be continued.

6. *Agaves.*—During the past two years a series of experiments with Agaves have been laid down with the object of comparing as many possible kinds with regard to the factors which determine the value of such plants as fibre producers :—

(*a*) Weight of leaf produced per acre.

(*b*) Percentage of fibre in leaf.

(*c*) Time of flowering.

These experiments will be continued.

In addition to the above items of work, it is understood that the following will also receive attention :—

(*a*) Extension of flax cultivation in Assam.

(*b*) Study of retting of jute.

(*c*) Investigation of heart-damage in jute.

(*d*) Investigation of sources of material for paper-making.

VI.—FISHERY.

(T. SOUTHWELL, A.R.C.S., F.Z.S., F.L.S.)

A.—Main lines of work and investigation.

I. Organisation on commercial lines of the fisheries at Puri, Balasore and the Chilka Lake, should this be found possible.

II. Improvement of tank culture and river fisheries; initiation of better methods of transporting fresh fish and of curing and salting, where these processes are necessary.

III. *A serious attempt will be made to induce capitalists to initiate fishing in the Bay of Bengal by means of steam trawlers.* A carefully prepared scheme will be placed before them and the commercial possibilities discussed.

IV. Increasing the fish supply to Calcutta, together with a lowering of the prices by means of items I, II, and III will be attempted.

V. A continuation of the investigation into the life history and habits of the common marketable fish.

VI. A continuation of the enquiry regarding the necessity of initiating fishery laws, where the results of work already done indicate such a necessity, and where such laws can be given effect to.

VII. A launch will be available about next January. Artificial culture of hilsa will then be attempted, and the breeding grounds of the commoner fish located.

VIII. Extensive propaganda work will be continued.

IX. Scientific investigations, particularly with regard to the principal good fishes, will be continued.

B.—Subsidiary lines of work and investigation.

I. Statistics will be obtained for the year 1914-15 for the reasons stated in the report submitted.

II. Enquiries into the jheel, estuarine, and casual fisheries, will be commenced.

III. Culture of certain tank fish, such as *sol* and *koi*, will be attempted if possible. These fish are hardy and can live for sometime out of water. They are considered excellent eating by Indians.

IV. Question such as the following will be investigated and considered :—

(*a*) Pollution of tank and rivers by jute steeping.

(*b*) Construction of fish ladders where necessary.

(*c*) The extent—if any—to which inland fisheries suffer by reclamation of land for agricultural purposes changes in the courses of rivers, etc.

V. Better organisation of the fish trade at the principal fishing places in the mufassal.

Such, in merest outline, will be the work proposed to be attempted by this Department during the year 1914-15.

VII.—SERICULTURE.

(APURBA COOMAR GHOSH.)

A.—Main lines of investigation.

(*a*) The Bengal silk industry is seriously threatened by the silk worm disease known as pebrine. The main work before the Department is to eliminate this disease by raising crops from seed (eggs) of unaffected parents. It is not

possible to be certain of the parents being healthy or otherwise, except by a microscopic examination of the male and female moths after they die. It is practically useless, except in very rare instances, to expect village rearers to be so careful of their seed. Many of them buy seed from Government nurseries, but the supply at present is very limited. It is therefore felt that the only thing that can save the situation is to have a sufficient number of Government nurseries, each in the centre of a group of rearing villages, for supplying healthy seed to the whole Province. It will necessarily take some years to give full effect to the scheme, but, in pursuance of it, a number of central nurseries will be established every year. During 1914-15 it is proposed to establish two such nurseries.

(b) The races of silk worm that are usually reared in Bengal are multivoltine, producing several crops in a twelve-month, while European, Chinese and Japanese races are univoltine, yielding only one crop in a year. But the cocoons of the Bengal silk worms are smaller, and the quality of their silk poorer than those of the foreign races. Mr. Lefroy, Imperial Entomologist, recorded his deliberate opinion that no amount of mere selection of the local worms would enable us to obtain from them silk of the European or Japanese quality. It is therefore proposed to obtain a hybrid of the European and chief Bengal races combining the multivoltine character of the latter with the superior quality of the former. Early in 1912 a French expert, named M. Lafont, was engaged for three years for this work, but unfortunately his health broke down and he was obliged to leave in January last. Arrangements have, however, been made to continue the work, and another French expert, named M. Grangeon, has been engaged, who is expected to arrive in October next. Like M. Lafont, he has also been engaged for three years.

B.—Minor lines of work.

(c) Pebrine being a highly infectious disease, a crop raised even from healthy seed is often infected by germs abounding in the rearers' own nurseries and rearing implements. It is therefore proposed as an educative measure to show them the value of disinfection. For this purpose a staff has been trained by the Sericultural Superintendent. This work will be extended and continued.

(d) Rearers' sons will continue to be trained in scientific methods of rearing at the Rajshahi Sericultural School.

VIII.—VETERINARY COLLEGE.

(MAJOR A. SMITH, I.C.V.D.)

My duties as Principal of this College and Controlling officer of the Glanders Department of this city leave me little time for research work. An extra officer with special training in research work is badly needed. Investigation into such diseases as are specially prevalent in Bengal, *e.g.*, paralysis in horses (*Kumri*), canker in horse's feet (*bursatti*), and a disease of cattle very prevalent in Eastern Bengal (local name *arryia*), about which little is known, in addition to many other diseases common to the whole of India, should be undertaken with much benefit to this province.

2.—BIHAR AND ORISSA.

I.—AGRICULTURE.

(G. SHERRARD, B.A.)

Work of primary importance.—The most important work on the various farms in my charge is that concerned with the further training of the staffs (consisting of one Superintendent and a varying number of Overseers on each farm). The opening of a number of farms and the necessity of filling the posts thus created with men capable of keeping the farm books and accounts has resulted in the somewhat rapid promotion of men not yet sufficiently trained. Attention must now be given to training them; first in agricultural practice and secondly in accurate experimental work.

Another important work which will be extended, it is hoped in the future, is that of demonstrations of recognized improvements carried out under the immediate control of the Department in villages near the central farms. Certain demonstrations, in particular of the value of green manuring rice, have given good results in the past, and these will be pushed more vigorously at all events in lands adjacent to the headquarters farm.

Dumraon.

Investigations of primary importance on this farm.—The principal crop treated is wheat. A certain amount of improved wheat has already been introduced into the neighbouring districts, and it is hoped to increase the area this year.

Investigations of secondary importance.—The crop of next importance on this farm is rice, and the work now in progress will be continued.

Bankipur.

Investigations of primary importance.—The Bankipur farm is chiefly on undrained rice land, and the villagers on the similar lands south and west only occasionally get good rice crops. This makes the work on the lower unirrigated area somewhat difficult but investigations will be undertaken to see whether transplanting with a smaller number of seedlings than that habitually used by the cultivators is as safe on unirrigated areas as it has been shown to be on the higher canal-irrigated lands both here and at Cuttack. Work of equal importance in this district is that on the *rabi* crops. The whole of this area grows good cold weather crops, the chief of which is gram, and an attempt will be made to select an improved variety of this grain.

Investigations of secondary importance.—A point of secondary importance, but one which requires investigation is the consideration of the best implements for working this heavy clay soil, having regard both to their cost and to their efficiency.

At Cuttack the manurial and cultivation experiments on rice will be continued.

The exhibition work and the supply of seeds to members of the Provincial Agricultural Associations will be continued.

II.—AGRICULTURAL COLLEGE AND ECONOMIC BOTANY.

(E. J. WOODHOUSE, M.A., F.L.S.)

At present my time is fully occupied with the routine College work, so that it is not possible to carry to a conclusion any piece of research work of major importance.

1. *College.*—Special attention is being given to the fitting up of the Museum, provision of quarters for the staff, and the completion of the laying out of the College grounds. The laying out of the College grounds has not been completed before because no funds have been obtainable for the work.

Major Works.

2. *Botanical investigation.*—Very little attention can now be given to this branch of the work owing to the time required to deal with routine. The work on Soy Beans is however being pushed forward as far as time permits. The other pieces of work are being brought to a conclusion and the results so far attained are being published.

Soy Beans.—(*Glycine Soja*) were first grown at Sabour in 1909 but serious work on the crop was not commenced until 1910 since when the work has been carried out in co-operation with the Agricultural Chemist. The results of the work up to the end of the 1911 season were incorporated in a Memoir of the Imperial Department of Agriculture (Bot. Series, Volume V, No. 3). The results of recent work have led us to recommend the Nepali variety of Soy Beans as a crop for cultivation in the Himalayas. At present our work is directed towards obtaining an early variety of high oil content suitable for growth in the plains. The types of beans grown all over India are also being studied. This line of work will be continued.

Minor Works.

In 1909 a set of the vaieties of *sugarcane* found in Bengal was collected by the Agricultural Chemist, and the work of determining the characters of agricultural value and those of value for purposes of classification was commenced in that year in co-operation with the Agricultural Chemist who undertook the chemical side of the question. In 1910 single plants were selected of each variety and since then all observations have been made yearly on these cultures. The work is now being brought to a close and the results obtained will probably be ready for publication during the current year. The single plant cultures will then be ready for handing over to the Sepaya Sugar station for the purpose of making trials of yield on a field scale. Sets of the cultures will also be available for distribution in order that the effect of climate on the quantitative characters may be studied.

The study of the cultivated species of the genus *Phaseolus* will probably be completed during the current year and a paper on the subject prepared for publication. Work on this crop was commenced in 1909 in order to get an idea of the systematic position and agricultural value of the very lagre number of distinct varieties of seed which I found to be exhibited in Exhibitions and of which I could find no clear account in Indian systematic works. A large number of varieties have been collected from all over Bengal (as it existed previous to 1912) and have been grown in pure culture.

The work on *Setaria italica* was commenced in 1909, as a result of observations on the variations in size and colour of the heads usually found in a normal crop. It has not been possible to carry out any further work on *Setaria italica* since 1911, when a preliminary note was published in the Bengal Quarterly Journal, Volume V, No. 4 of April 1912. Since that time the single plant cultures of the selected types have merely been carried on. Within the species there are a very large number of unit characters and it should certainly repay study botanically and agriculturally.

The preparation of a *natural history of the local flora* for use in the College teaching has been in hand since January 1911, but the progress made is slow owing to the press of teaching work. On completion of the above items of work it is hoped that it will be possible to write this up.

3. *Biological and Horticultural teaching.*—This will be continued. The Botanic garden will be maintained for teaching purposes. A vegetable garden has been started with the object of demonstrating good methods of garden cultivation and will probably be continued.

Major Works.

4. *Crop pests.*—The campaign against *Agrotis ypsilon* at Mokameh was commenced in the cold weather of 1910. In 1911 the damage was reduced from 10,000 acres to about 3,500 by handpicking the early brood. In 1912 the whole crop worth over three lackhs was saved by the use of Andres Maire moth traps. In 1913 the traps will again be used and further attempts will be made to find where the insect æstivates with a view to finding a still more vulnerable point in its life history. A campaign against the same pest on about 6,000 acres at Colgong is being opened in the present year and will probably be continued.

The campaign against the *potato moth*, which appeared in 1907 and has since spread all over the Province, is now being carried on at Bankipur, Bihar, Bhagalpur, Colgung and Purnea where the method of storing the potatoes under sand is demonstrated. The work is complicated both by the appearance of fungus and bacterial diseases which are being investigated here and at Pusa, and by the differences in the climatic conditions at the different centres. Up to the present time the sand method of storage has been universally adopted by the cultivators round Bankipur and by a large number of those at Colgong. Progress at the other centres has not been so rapid.

Measures for minimizing the damage done by a Tingid bug to the potatoes at Toonia (Bettiah) are under trial and an experimental godown has been opened. The work on the prevention of damage to stored potatoes will be continued.

Minor Works.

Other pests are dealt with by the issue of leaflets or otherwise as they occur.

III.—AGRICULTURAL CHEMISTRY.

(C. SOMERS TAYLOR, B.A.)

Main lines of investigation.

1. *Sugarcane.*—The main work of the Agricultural Chemist will be in connection with investigations upon the sugarcane. It will continue on the following lines :—

(a) Examination of the quantity and character of the fibre of the cane varieties in Bihar and Orissa.

The aim of this work is to obtain information as regards the properties of the canes grown in the Province regarding their behaviour in the mill. Some interesting results have already been obtained in connection with this work which have been forwarded for information to the proper authorities.

(*b*) Examination of the salts in the juice of different varieties grown under the same condition.

(*c*) On the effect of different modes of treatment on the time of ripening of the cane.

Experiments have already been carried out in the past year which have given results coinciding with those obtained by workers in other parts of the world and which have been forwarded for information to the proper authorities.

II. Soy Beans.—Continuation of work on Soy Beans in co-operation with the Economic Botanist.

This, although not perhaps of such importance as the sugarcane investigations, is of great interest and interesting results have been obtained which have recently been published.

Minor lines of investigations.

1. An examination of the rice soils in the Cuttack district. This is only commencing with the object of determining whether it is possible to ameliorate the condition of rice soils of Orissa by any treatment different from that which they experience.

2. Such routine analysis as may from time to time occur in connection with the general work of the Department.

The Agricultural Chemist is also responsible for the teaching of Chemistry and Physics in the Sabour Agricultural College.

IV.—AGRICULTURAL COLLEGE AND CENTRAL RESEARCH STATION, SABOUR.

(N. S. McGowan, Dip. in Agri.)

1. The educational work of the College will take up the greater part of the time as in addition to the three lots of regular students for the College Diploma, two short courses of instruction have been opened for *bonâ fide* Zemindars and cultivators.

Major Works.

2. *Maize.*—Five or six varieties of American Maize have been imported from the Southernmost States for trial on the farm. Comparative trials in yield, resistence in the case of water-logging and different methods of sowing will be made between the Jaunpur and local varieties.

It is hoped to raise hybrid varieties suitable to local conditions.

3. *Paddy.*—Contrary to the results obtained in other Provinces and on some of the Bengal and Bihar farms, *late* transplanting of two and four seedlings per hole did not give as good results as the local method of six or more seedlings. This experiment is being repeated this season to verify last year's results.

The following investigations are also being made :—

(*a*) The effect of bone-meal on paddy lands, (the Agricultural Chemist is of opinion that the addition of phosphates is not necessary on the light upland soils of the Farm, and it is necessary to ascertain if this opinion also holds good for the paddy area).

(*b*) The green manuring of paddy with *dhaincha* and *Sunn* hemp is being continued for four years with a view to ascertaining :—

(*i*) The interval which should be allowed between two green manurings.

(*ii*) The effect of lime on a green manured plot.

(*iii*) The difference in outturn of paddy between plots green-manured with *Sunn* hemp and with *dhaincha*.

(*c*) The comparative effect of different organic and artificial manures.

(*d*) Other points

(1) Wet and dry seed-beds.

(2) Seed rate per acre.

(3) Spacing of seedlings.

(4) Broad-casting *versus* drilling, *versus* transplanting.

4. *Mustard.*—A manurial rotation for maize followed by mustard.

5. *Pusa wheat.*—The trial of Pusa wheats on the Farm showed that a good yield could be expected in South Bihar, and the work of bringing this fact to the notice of the Zemindars and cultivators of the Bhagalpur Division has been given to the Professor of Agriculture. Preliminary arrangements have been made this year with Zemindars to put down about 200 acres under the wheat in different parts of the division, and a comparative trial of the best varieties has also been arranged in certain areas, to ascertain if any one variety is more suitable to the local conditions than another.

Minor Works.

1. The preparation of ensilage will be continued.

2. The drainage system of the Farm is being altered in accordance with the recommendations of the Agricultural Adviser, *i.e.*, each plot to have an independent drainage system, and following the method of the Imperial Economic Botanist will also have a broad strip of "turfing" in place of "ails."

3. Deep *versus* shallow cultivation will be continued with the Punjab or Rajah plough against the country plough as last season's results showed that the former implements reduce the cost of cultivation and improve the outturn.

4. The potato seed of last year's infected crop is being kept to carry out certain investigations under the direction of the Imperial Mycologist.

V.—FISHERY.

(T. SOUTHWELL, A.R.C.S., F.Z.S., F.L.S.)

(A) Main Lines of Work and Investigation.

I. Organisation on commercial lines of the fisheries at Puri, Balasore and the Chilka Lake, should this be found possible.

II. Improvement of tank culture and river fisheries, initiation of better methods of transporting fresh fish and of curing and salting where these processes are necessary.

III. A serious attempt will be made to induce capitalists to initiate fishing in the Bay of Bengal by means of steam trawlers. A carefully prepared scheme will be placed before them and the commercial possibilities discussed.

IV. Increasing the fish supply to Calcutta together with a lowering of the prices by means of items I, II, and III, will be attempted.

V. A continuation of the investigation into the life history and habits of the common marketable fish.

VI. A continuation of the enquiry regarding the necessity of initiating fishery laws, where the results of work already done indicate such a necessity and where such laws can be given effect to.

VII. A Launch will be available about next January. Artificial culture of Hilsa will then be attempted and the breeding grounds of the commoner fish located.

VIII. Extensive propaganda work will be continued.

IX. Scientific investigations, particularly with regard to the principal good fishes, will be continued.

(B) Subsidiary Lines of work and Investigation.

I. Statistics will be obtained for the year 1914 to 1915, for the reasons stated in the report submitted.

II. Enquiries into the Jheel, estuarine, and canal fisheries, will be commenced.

III. *Culture of certain tank fish such as sol and koi will be attempted if possible.* These fish are hardy and can live for sometime out of water. They are considered excellent eating by Indians.

IV. Questions such as the following will be investigated and considered :—

(*a*) Pollution of tanks and rivers by jute steeping.

(*b*) Construction of fish-ladders where necessary.

(*c*) The extent to which inland fisheries suffer by reclamation of land for agricultural purposes, changes in the courses of rivers, etc.

V. Better organisation of the fish trade at the principal fishing places in the mufassal.

Such, in merest outline, will be the work proposed to be attempted by this Department during the year 1914-15.

VI.—VETERINARY.

(D. QUINLAN, I.C.V.D.)

Combating cattle diseases in the Province and testing the efficacy of the different sera and vaccines that are now in use. No time for scientific research.

3.—UNITED PROVINCES.

I.—AGRICULTURE, WESTERN CIRCLE.

(RAI SAHEB GANGA PRASAD, *in charge.*)

1. *Kharif.*—Comparisons of various types of American cotton with country cottons from the point of view of yield per acre.

2. Selections of American cottons in order to get a type suited to the locality.

3. Trials of cotton passed on by the Economic Botanist.

4. Cultivation experiments with cotton, maize, groundnuts and juar.

5. Arhar selection work.

6. Variety tests of groundnuts, maize, juar, soybeans and jute.

1. *Rabi.*—Variety tests of wheat and gram.

2. Cultivation experiments with wheat and gram.

1. *Zaid crops.*—Variety experiments and cultivation experiments with sugar-cane.

2. A survey of the sugar-canes of the Rohilkhand Division.

1. *Other experiments.*—Experiments in sheep breeding.

2. Usar reclamation by flooding.

The above is experimental work.

Demonstration work will go on as follows with varieties and methods which have already proved successful :—

1. Wide distribution of white-flowered cotton.
2. Distribution in the Terai of selected yellow-flowered cotton.
3. Distribution of improved varieties of thick and thin sugar-canes in certain tracts.
4. Demonstration of an improved method of sowing maize.
5. Wider introduction of groundnut cultivation.
6. Demonstrations to show the best method of coping with the rice-bug in Rohilkhand.
7. Buying back *kapas* in order to get seed for wider distribution in the following year will take up a considerable amount of time.

II.—AGRICULTURE, CENTRAL CIRCLE.

(B. C. BURT, B. Sc., F.C.S.)

Most of the permanent and manurial experiments have now been discontinued as not being likely to lead to further results of value; the continuous wheat growing series is being retained for the present with slight modifications.

Cotton.—Owing to a market now being guaranteed by local spinners, the growing of acclimatised American cotton is now feasible. It has been shewn that the yield of the Cawnpore-American variety when sown with irrigation at Cawnpore was eqnal to that of good irrigated *desi* cotton: the local mills place the lint as about 5 per cent. less valuable than imported middling American, and their opinion, which is the result of actual comparative spinning trials, is in the main confirmed by the British Cotton Growing Association and Bombay valuations. There appears to be room for improvement in the percentage of lint and in uniformity and an attempt is now being made to select suitable pure lines. Certain recent importations are also under observation.

The Aligarh selected variety of *desi* cotton has been found suitabe for un-irrigated sowings in part of the Central Circle and is being introduced. Certain other selected types of *desi* cotton are being tested at Cawnpore and two of these show promise. An attempt is being made to isolate definite types from certain of the Bundelkhand cottons. Work on these lines will be continued.

Wheat.—Two Pusa wheats have been found to be suitable for general distribution in part of the circle and seed for about 1,800 acres is being issued this year:—a third variety suits the submontane districts. Promising varieties received from the Economic Botanist will be tried both on the farm and also in the districts prior to general demonstration.

Arhar.—An early ripening variety has been found to be particularly valuable for districts where this crop is sown with cotton and demonstrations with this are in progress and a stock of pure seed is being multiplied.

Groundnuts.—This crop is now fairly established and is spreading naturally and there is not much need for further demonstration except in new districts. Comparison of different varieties and the testing of suitable rotations and mixtures will be continued.

Juar.—Certain selected types are being tested and experiments are in progress with methods of drill sowing.

The principal lines of work at the Cawnpore farm are concerned with wheat and cotton and the seed farm is entirely devoted to the production of pure seed of these crops for distribution together with certain large scale experiments on the same crops.

Implements.—The testing of agricultural implements is being continued. Successful results have been obtained with a steam thresher; a good type of winnower has also been obtained.

Orai.—This farm is situated in the black soil wheat growing tract and is largely devoted to the testing of wheat varieties for Bundelkhand. Successfol results have been obtained with a selected *durum* wheat from Hoshangabad which is being issued on a considerable scale for un-irrigated sowings. Two Pusa wheats are promising for irrigated sowings and are being tested further but none of the common wheats tested so far do well on un-irrigated black soils of the type common in Bundelkhand. A selected local wheat also does well on the irrigated soils and is being issued.

From the collection of the Bundelkhand *Juars* made by my predecessor a number of promising types have been isolated and tested and the distribution of the best of these has now begun; this work will be continued.

A small portion of the farm is suitable for cotton growing and the testing of selected *desi* cottons for suitability to Bundelkhand is in progress. Experiments are also in progress with groundnuts, *arhar* and gram. Cultivation experiments on the typical Bundelkhand soils and on the eradication of *kans* are being continued. Very definite results have been obtained by growing wheat and gram in rotation instead of mixed and these will now be demonstrated. It is becoming more obvious every year that *kans* can be kept down by reasonably good cultivation if once cleared by deep ploughing bnt to do this on any large scale necessitates the use of mechanical means and it is hoped to take this question up.

Atarra.—The equipment of this farm is now fairly complete; it is situated in a new canal area which from next year will obtain hot weather irrigation and which is suited to sugar-cane cultivation. Preliminary experiments with local canes and with selected varieties recommended by the Agricultural Chemist have been made and satisfactory yields obtained. The best varieties will be issued as soon as water is available. This tract is also suitable for growing irrigated cotton and this will be taken up as soon as irrigation is available; some preliminary experiments are in progress. Varieties of wheat are being tested for suitability to the "Parwa" tract and experiments with groundnuts and juars are also in progress.

Demonstration farms and district work.—As will be inferred the principal demonstrations are connected with American and selected *desi* cottons and methods of sowing; Pusa wheats, early *arhars*, selected juars and groundnuts.

The demonstration of suitable implements is steadily continued both in villages and at Agricultural shows. The introduction of Jaunpur maize in two districts is being continued. The supply of ordinary wheat seed in Bundelkhand is being discontinued from the present year as the wheat area has now approached the normal and there is a sufficient supply of ordinary seed; the organisation established is being utilised for the introduction of the selected *durum* wheat already referred to.

The Central Circle does not include any of the large sugar-cane tracts but considerable quantities of cane (about 30 tons) of selected varieties have been supplied for sowing; as a result of demonstrations, a number of three roller cane mills have been sold.

Demonstrations of methods of potato storage to avoid loss by the potato moth are in progress in the Farrukhabad district where the loss is heavy.

Most of the demonstration work is being carried out in conjunction with Co-operative Societies who are also the best distributors of improved implements. One district association is doing good work and a number of individual Zemindars are carrying out small demonstrations under our supervision. Advantage is also being taken of the co-operation of some of the larger Court of Wards Estates for the issue of seed—particularly of wheat but also to a less extent of cotton and sugarcane.

III.—AGRICULTURE, EASTERN CIRCLE.

(L. C. SHARMA, M.R.A.C., P.A.S.I.)

1. Experimental Investigations.

CROPS.

Sugarcane.—The methods for improving sugar-cane consist of:—

(a) Trial of cultivation experiments such as seed rate; ordinary *vs.* improved cultivation with a view to ascertain which method could secure the highest profit on the crop with the minimum expenditure.

(b) Trial of varieties in order to test their relative merits as sugar yielders in addition to the manurial experiments will be continued. Slow and rapid ripening varieties of sugar-cane as well as early and late varieties will be studied. Ashy Mauritius gave 101·5 mds. of *gur* per acre. Some of the thin varieties too gave very satisfactory results.

Wheat.—Varietal experiments with this crop to determine their suitability to the locality, in addition to the seed rates, early and late sowing, and the green manuring *versus* fallow or farm yard manure with this crop will be continued. Muzaffarnagar variety always gave the best results but as it needed one or two more irrigations (not ordinarily available in the Eastern districts) some of the Pusa wheats were also tried—Nos. 12 and 8 which gave the highest outturns of splendid quality of wheat requiring less irrigation. A big demand for these varieties has already been jumped up. These varieties will be tried on a much larger scale this year.

Paddy.—The methods of improving paddy cultivation consist of (a) varietal experiments (to determine their suitability to the locality), (b) seedling experiments (the transplantation of one, two and three seedlings of *hansraj* variety will be compared to ascertain which process will prove more profitable), and (c) spacing experiments (transplanting 4, 6 and 8 apart of one seedling in one set of the plots, of two seedlings in the second, and of three seedlings in the third to determine which course will give the best results).

All these experiments will be continued in addition to the manurial experiments with this crop. Only those manures which can easily be obtained will be tried.

Cotton.—Varietal experiments with this crop in order to determine their suitability to the locality will be continued in addition to the early and late sowing specially of the *Buri* cotton variety which gave very satisfactory results in the year 1912-13. Better results are expected this year.

Groundnuts, Maize, Potatoes and Barley.—The varietal experiments with these crops will also be continued. The object is to determine their suitability to the locality. Jaunpur variety of maize is getting very popular with the cultivators and the demand for its seed is very rapidly increasing.

Darjeeling potatoes among the Hill varieties and *Phulwa* and Madrasi of Farrukhabad among the local varieties have given the highest turn. Darjeeling variety also appears to be a resistant to the hot weather and potato moths to some extent.

Sann Hemp.—Varietal experiments with this crop to determine their commercial qualities will be continued.

Miscellaneous crops such as Jaunpur Bajra, Juar, and early Arhar, etc., will be tried in rotations with other crops and also as mixed croppings to ascertain which of the methods is a more paying concern.

II.—Trial of improving alkaline lands and ravines so as to render them fit for growing trees such as Babul, *Mahua* and *Sheesham*, and some specified crops will be continued. Babul, Mahua and Sheesham trees that were planted a few years ago are doing very well so far.

III.—Hot weather cultivation with wheat has proved very profitable in various places in the Eastern Circle. It will be demonstrated on a larger scale in suitable places.

IV.—Distribution of selected seeds through the agency of Seed Depôts will be continued. Only these seeds are distributed which can confidently be recommended as an improvement on the existing seeds.

V.—Agricultural demonstrations will be given in various places on the following :—

(a) Improved implements.—To get the cultivators familiarised with the use thereof.

(b) Eradication of *rarhi weed* by ploughing up the land with Watts or turnwrest ploughs, picking out the roots and runners of the grass and burning them on the spot will be continued.

(c) Cultivation of thick varieties of sugar-cane in trenches, and

(d) Introduction and extension of improved crops in the localities where the results of our demonstrations proved successful.

VI.—Mufid-ul-Mazarain. This is a monthly Vernacular Journal issued by the Department. Great efforts are being made to make this Journal a valuable one and popular with the Zemindars and the cultivators.

IV.—ECONOMIC BOTANY.

(ANDREW WILSON, M.A., B.Sc.)

(1) A continuation of the cotton investigations now in progress.

(2) A continuation of the wheat investigations now in progress.

V.—AGRICULTURAL CHEMISTRY.

(G. CLARKE, F.I.C.)

(*i*) The practical and theoretical teaching in Chemistry and Physics of the College and the routine chemical work connected with the central laboratories.

(*ii*) The charge and equipment of the Sugar Experimental Station at Shahjahanpur. The collection and testing of the indigenous canes of the Rohilkhand Division. The collection and testing of imported foreign varieties. Investigation of the period of ripening of selected varieties.

(*iii*) The chemical work in connection with the canes of the Aligarh station will be continued this year in collaboration with Dr. Parr.

The above are the principal lines of work.

The study of the Organic Phosphorus compounds in cereals will be continued with special relation to Indian wheat.

VI.—VETERINARY.

(C. W. WILSON, M.R.C.V.S.)

1 Main lines of investigation :—

(a) Cattle.

Piroplasmosis, Surra, Tuberculosis among dairy cattle. Extent of which tuberculin test can be safely applied. Applications of ophthalmic test with concentrated tuberculin.

(b) Horses.

Surra, Dourine, Biliary fever, Kumri.

(c) Poultry.

Spirochetosis, fowl-cholera.

2. Subsidiary lines of investigation :—

(a) Cattle.

The extent of which the mammary glands of milch cattle are affected with tuberculosis.

No definite programme of work relating to tuberculosis can be given since previous sanction from the Local Government will have to be obtained before any investigation can be made.

The work in progress will continue on the same lines with further attention to the supply of suitable cattle for breeding purposes and in addition steps will be taken towards practical use of the knowledge obtained from the experiments already made for the improvement of the wool of country sheep by crossing with merino rams. Considerable time will be spent in improving stud bulls now being issued from the Manjhra cattle farm and also in the taking up of and stocking of the newly acquired farm at Madhorikhand in the Muttra district.

4.—PUNJAB.

I. —GENERAL.

(W. S. Hamilton, B.A., I.C.S., Director of Agriculture.)

These programmes indicate in outline the work that will be done. There is in existence a separate detailed programme of cotton work. It is not known what is the test by which to determine whether a line of work is "main" or "subsidiary." Those which appear to be "main" have been shewn in heavy type.

DISTRICT WORK.*

1. *Demonstrations of implements and methods of cultivation.*

These have been given for some years past in several districts, both in Zemindars' own fields and in fair grounds. They will be continued, more especially in the six districts in which agricultural associations have been formed.

(1) *Ploughs.*—The *Rajah plough* is appreciated by people who can afford it, especially when their land is much overgrown with grass.

The *Meston plough* (Ransomes, Sims and Jefferies) is establishing itself by its light draught and low price.

The steel bar plough (Ransomes, Sims and Jefferies) is being used in a few places for deep ploughing for sugarcane.

(2) *Harrows.*—Spring tined harrows have been shewn to the people but their heavy draught and cost have prevented purchasers coming forward.

Chain harrows.—Forty-eight of these have been lent out for harrowing young wheat, harrowing land planted with sugarcane, and generally breaking the crust, but they have been successful only in light lands.

Some *lever harrows* will be given out on trial in the coming year.

(3) The sowing of cotton and maize in lines and inter-tillage have been demonstrated. This will be continued.

2.—*Seed production and distribution.*

(a) Moderately large land-owners in the areas where the seed is to be distributed have been selected as seed growers, and several hundred acres of cotton seed (G. *sanguineum* and American) have been sown this year, and several hundreds of wheat seed (chiefly type No. 11 in Lyallpur and types Nos. 13 and 14 in Jullundur Gurdaspur and Hoshiarpur) will be sown next harvest. This system will be developed. It is hoped that co-operative societies in suitable centres will buy up the seed and distribute it to their members.

(b) The Department has taken over control of the so-called Sargodha seed farm, which will in future be used for the purpose indicated in its name. It will be the head-quarters of an agricultural assistant who will assist and advise cultivators in the neighbourhood and give demonstrations.

3.—*Methods of converting the cultivator.*

(a) Agricultural associations of 50 or 60 persons, mostly members of co-operative societies and self-cultivating owners, have been formed tentatively in six districts—as many as can be worked with the present staff. Each member is required to carry out in his own land some improvement recommended by the Department and to report results. Implements are in some cases lent out for a year's trial. An agricultural assistant tours round to see that proper work is done. The constitution of the associations will be consolidated and the amount of work given them to do will be increased.

(b) In two districts small blocks of land were taken over temporarily and cultivated by the Department as demonstration plots in the growing of wheat. This will be continued.

(c) About 20 acres of land are being taken on lease for five years in the Attock district and will be worked as a demonstration of dry farming especially of wheat. Demonstrations will be given in the neighbourhood.

4.—*Wheat and cotton surveys.*

The predominant wheats in the districts of Hoshiarpur, Jullundur, Ferozepore, Gurdaspur, Gujrat, Jhelum (parts), Attock (parts), Montgomery and Lyallpur and the predominant types of cotton in Lyallpur have been ascertained. The survey will be undertaken gradually in all the districts of the province.

5.—*Reapers.*

They have been found economical and useful for canal colonies, but many are lying unused, as it is more profitable for tenants to employ their relatives to hand-reap the crop. A class is held annually at Lyallpur.

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* All are main lines of work.

6.—*Steam threshing machinery.*

Demonstrations of steam threshing were given this year. *Bhusa* was good and grain unbroken, but the output of dressed grain was under 10 maunds an hour. It is hoped that with a 42" drum the outturn will be improved, and it is proposed to try a thresher of this size next year.

7.—*Well boring.*

There are 20 plants in operation. The aim of the work is to improve the water-supply in existing wells. The operations were started in 1910, and till the end of June 1913, 425 wells had been bored and the supply increased in 244. The work will be continued on the same lines as before in localities where successful results have been obtained. This work will not be satisfactorily carried out until there is an agricultural engineer to control it.

II.—AGRICULTURAL CHEMISTRY.

(J H. BARNES, B.Sc., F.I.C., F.C.S., A.R.I.P.H.)

1.—Alkali lands.

The investigations carried out up to the present on the nature and extent of the sterile soils and the physical causes which lead to their production indicate washing with water combined with adequate drainage as a rational method of cure. An experimental farm is to be started at Narwala of some 140 acres, about 40 per cent. of which is sterile with alkali salts at present. The land is to be mole-drained by machinery and washed with irrigation water. Full analytical records will be taken of the changes effected in the soil, with special reference to fixing the lowest limit of washing required for successful plant germination and growth. This work will commence in the cold weather of 1913-14.

2.—Sugarcane Survey of the Gurdaspur District.

The analytical survey of the canes of this district, the sugar contents and ripening period will be carried out for a further season so as to secure continuous records for a period of three years and obtain some idea of the average composition and climinate to some extent the factor of seasonal variation. The main object of the work is to gain some knowledge of the sugarcanes of one of the best sugarcane districts of the province, and to see how far they are suited for centralised sugar production. I do not consider central factories possible in this district with the present canes. In addition to this, however, valuable information is being obtained on the nature and quality of hitherto little known canes and the mechanism of the ripening process.

3.—Canal seepage.

The results obtained so far on this important investigation seem to show that the rise of the well water level throughout the colony is only partially due to what is termed canal seepage, and can only be temporarily and partially checked by lining the canals with a water-proof layer. The inference is that water-logging over the bulk of the colony is inevitable. The line of investigation being followed is a physcial one, the physical condition of the soil gases and of the air in contact with the soil being studied.

The work will be continued for a further six or eight months to confirm and extend my present results.

4.—Analysis and advice for the Department of Agriculture and Industries.

5.—*Preservation of the stored grain against weevil attack.*

The results obtained up to the present show that although sulphur dioxide destroys the weevil, it also injuriously affects the germination. Carbon disulphide or benzene is dangerous for killing weevil in stored grain. Carbon dioxide has proved fatal to the weevil, but in some cases the germination of the grain has also been affected. Further work on this will be carried out at Lyallpur in collaboration with Mr. Grove, the Supernumerary Entomologist, and will take the form of working out the life history of the various pests classified under this heading, and the method of applying the treatment so as to render an effective cure and at the same time leave the grain undamaged.

NEW WORK.

6.—*Nitrogen value of Punjab soils.*

Experiments are to be instituted in co-operation with the Professor of Agriculture and Deputy Director on the effect of various methods of cultivation and green manuring under irrigation and under *barani* conditions on the nitrogen contents of the soil. This will be undertaken if time is available.

Subject 6 in last year's programme (the value of the silts of the Chenab and Jhelum rivers) has been dropped as time and staff cannot be spared from more important work.

III.—ECONOMIC BOTANY.

(S. MILNE, M.A., B.Sc.)

1.—Wheats.

Small plots of the Punjab wheats classified by the Imperial Economic Botanist will be grown on the botanical area for demonstration to students and in order to supply pure seed of the types if required at any future time. The survey work on wheats in the districts will be continued : a large number of wheats not previously classified have been found in connection with the above work. These wheats are being classified and will in due course be tested as the wheats already classified have been. Some work has been done on crossing and will be continued as far as time will permit.

2.—Barleys.

Considerable interest has been aroused at home lately regarding the value of Punjab barleys for malting purposes. Last year a collection of barleys from the principal barley-growing districts was made. These were grown on the Layallpur experimental area in the past season, and have now been classified. They will be tested for malting and agricultural purposes in due course.

3.—Native cottons.

The native cottons collected in 1909 from the different districts of the Punjab and North-West Frontier Province have been classified after the system adopted by Professor Gammie, and the following cottons have been found :—

Genus.	Species.	Agricultural race.
1. Gossypium	Sanguineum	Leaf broad lobed.
2. „	„	„ narrow „
3. „	„	Variety minor leaf broad lobed.
4. „	„	„ „ narrow
5. „	Herbaceum.	
6. „	Indicum.	
7. „	„	var. Mollisoni.
8. „	Neglectum.	
9. „	„ .	var. Rosea.

The types have been examined by Professor Gammie and the above classification has been confirmed by him. Further work of selecting and improving cottons within these types is going on. The work now in hand of comparing and testing the agricultural races with a view to discovering which will be most profitable to the Zamindars will be continued. A pure variety of *Gossypium sanguineum* has been handed over to the Professor of Agriculture. It is hoped to hand over some one or more varieties of *Gossypium indicum* and *neglectum* during the year.

The work in connection with crossing of cottons will be continued as far as the time will permit.

4.—Dharwar American cottons.

Some selections of acclimatised Dharwar American cottons, much superior to what is grown by ordinary Zemindars have been handed over in the past years from the botanical section to the agricultural section. Work on selection of these cottons and of acclimatization of some recently imported Upland American cottons will be continued.

5.—*Date palms.*

Some 5,000 Arabian trees have been imported and planted, chiefly in the western side of the Province. Some Arabian trees planted in 1910 at Lyallpur bore fruit in 1912, and they, with several more of these trees in Multan and Muzaffargarh districts, are bearing fruit this year. The varieties of the trees already imported will be determined and their relative suitability for the Punjab will be ascertained. More trees will be imported if it is found that they are wanted—

(*a*) for model date plantations in the western Punjab ;

(*b*) for sale to private persons and other departments of government.

A memoir on date culture is in the press, and a vernacular edition of it will be issued as soon as possible. Demonstrations have been and will be given in the art of hand pollination and other points connected with date culture.

6.—*Grams.*

A botanical survey of the grams of the Province will be made. A collection of grams from all districts in the Punjab is being made this season.

7.—Maize.

A number of varieties of maize have been collected and will be tested with a view to discovering which are the best.

8.—*Miscellaneous.*

Several other experiments in hand will be attended to as far as time and staff will permit.

IV.—ENTOMOLOGY.

(LALA MADAN MOHAN LAL, B.SC.)

1.—The Sugarcane Moth-borers.

Investigation of the kind of borer provalent in each tract : study of those borers.

The most serious of them appears to be *Chilo Simplex* Butl, which attacks young cane shoots. Experiments have shown that the regular cutting out of "dead hearts" is valuable against this pest. Efforts will be made to induce cultivators to take to it as a regular agricultural practice.

The comparative liability of the principal varieties of cane to attacks by borers will also be determined.

2.—The Cotton Bollworm and its parasites.

The life histories of the cotton bollworm and its parasites have been studied. Parasites (*Rhogas Lefroyi*) are bred at Lyallpur and sent out in parasite boxes to districts where there are serious outbreaks of bollworm.

This work will be continued. The influence of rain and drought on the development of bollworm in cotton will be further investigated. The practical means of destroying bollworm besides the artificial introduction of parasites are :—

(1) Plucking off the early infected buds, flowers and bolls. This is a tiresome operation.

(2) Shaking the cotton plants by a drawn rope or otherwise, so that the worms may fall down, and then irrigating so as to drown them. (This operation is carried out by nature when the early monsoon rains are good.)

These will be taught and practised as far as possible.

3.—*Sericulture.*

The European varieties of silkworms have been profitably reared in new localities by Zamindars. This industry will receive close attention, and will be strengthened and extended as a cottage industry under supervision. Effort will be made to popularise it by introducing it amongst boys in suitably situated primary village schools. Arrangements are in progress to secure the timely and regular incubation of seed.

4.—*Investigation of the crop pests at the Lyallpur farm and the testing of remedies wherever possible.*

5. Assistance will be given in coping with outbreaks of insect pests in the districts. For the next couple of months, time will be spent on locusts which are gaining ground in the Province.

V.—AGRICULTURAL COLLEGE AND CENTRAL RESEARCH STATION.

LYALLPUR AGRICULTURAL STATION.

The following work, which is already in progress, will be continued :—

1.—Manurial and rotation experiment.

(*For details see Annual Report for 1912.*)

Up to date the sugarcane crop has benefited from combined dressings of organic and nitrogenous manures. The residual value of the manures has been felt by the maize crop in the next year, but in the third year after application no residual effect is noticeable on the cotton crop.

2.—Manurial experiments with sugarcane, maize and cotton in kharif series, and gram, wheat and *toria* in rabi series.

This experiment has been in progress for only two years, and accordingly no conclusion can yet be drawn. The object of the experiment is to study the behaviour of the soil with regard to manure and to ascertain which element or elements of plant food are most lacking.

3.—*Trial of wheat varieties.*

Types Nos. 8 to 25 were grown last year; types Nos. 9, 11, 13 and to a less extent 16 being grown on large areas. The conclusion arrived at up to date is that type No. 11 is the most suitable wheat on the whole for the colony. Its seed is this year to be multiplied on seed farms.

The Pusa wheats under trial have shown no superiority over Punjab wheats. Pusa No. 2 is of very nice quality and has yielded well; it is however a beardless variety and is thus unsuited to the colony. Pusa No. 9 E has shown itself inferior to Punjab No. 9 and will consequently be discarded. The remaining varieties will be grown again this year.

TRIAL OF COTTON VARIETIES.

4.—*Country cotton.*

Multan cotton (*Gossypium sanguineum*) known as "farm selected" has continued to show itself superior to the mixed crop grown in the colony. One hundred acres of seed farms have this year been sown for the multiplication of seed. Of the types handed over by the Economic Botanist for trial on larger areas a broad-leafed strain of *Gossypium sanguineum* appears to be a better yielder than ordinary farm selected, which consists of both broad and narrow-leafed plants. A further trial is being given to this variety. Next year the Economic Botanist will hand over some of the types found in Hissar cotton (*Gossypium indicum and neglectum*), and these will be tested with a view to multiply the best agriculturally.

5.—*American cotton.*

American cottons of types Nos. 3 F and 4 F, have again done very well. The former is the earlier variety. The first flowers of *desi* cotton were destroyed by bollworm this year, and hence American, which was not affected except to a very slight extent, was earlier than *desi* and yielded much better. The cultivation of American cotton is being taken up by Zamindars on all sides. Four hundred acres of seed farms have this year been sown with 3 F.

A few other types of American cotton handed over by the Economic Botanist are also being grown on the farm. They are being tested against No. 3 F, and of these Nos. 126 F and 168 F show most promise.

6.—Comparison of *desi* and furrow turning ploughs.

The land on which this trial is being carried out is uneven in quality, and so the results are of little value. Two squares of uniform land have recently been acquired, and this experiment will in future be conducted in the new area.

7.—Hot weather *versus* rains ploughing for wheat.

There has been for the last two years a slight increase in yield in favour of hot weather ploughing. The trial will be continued. The remarks made in the previous paragraph as to the unevenness of the experimental plots apply here also, though to a less extent. This experiment also will be transferred to the new area. The results show a slight increase during the last two years in favour of hot weather ploughing, though little reliance can be placed on them.

8.—Green Manuring experiments.

The ploughing in of green crops of sunn hemp has again proved a valuable means of increasing the fertility of light land. The practice is being advocated in the colony.

9.—Trial of new implements.

will be continued.

The Rajah plough and the spring tined cultivator are the main implements of cultivation on the farm. In addition to these Planet junior horse hoes have proved of great value in keeping down weeds in the cotton crop and in mulching the surface after irrigation or rain. Peg tooth harrows have been useful for working land quickly to a tilth and for harrowing crops.

The following work of minor importance will be continued :—

10.—Sub-soiling for sugarcane.

Up to date little benefit has been derived from sub-soiling. This will be continued.

11.—Cattle feeding experiments.

Rough feeding trials have now been in progress for two years. The number of cattle however at Lyallpur which can be used for such trials is small, and consequently the results are not of great value. Cattle fed on cotton cake have this year kept in as good condition as gram-fed cattle. The trials will be continued on the dairy cattle.

12.—Poultry breeding.

Exotic fowls have been a failure so far owing to the enormous mortality in the hot weather. It has been decided to limit work to the study of four varieties of exotic fowls, *viz.*, Rose Comb Minorcas, White Orpingtons, White Wyandottes, and Buff Orpingtons, and to selection among *desi* fowls, a number of which were bought recently at Gujar Khan.

The following new work will be commenced :—

13.—A study of the water requirements of crops.

The scheme for an improved water-course with modules for this work has been sanctioned, and it is hoped that the work of aligning the water-course and putting in the modules will be finished in time for the next rabi crop. A square of land has been laid out into plots with a view to using it for this work ;

14.—Dairy.

A small dairy and a cow byre for the accommodation of 20 cows are on the point of completion. This is primarily intended for the teaching of students. A square of land is being laid down to grass for the cows. In this square pasture experiments will be commenced with a view to test different varieties of grass and to ascertain the effect of different numbers of waterings upon the quality of the pasture.

VI.—AGRICULTURE.

Gurdaspur Agricultural Station.

1.—Crops.

Wheat.—The aim is to find a suitable type of wheat for *barani* tracts. So far Nos. 13 ond 14 and Pusa No. 12 have given good results, and these will be thoroughly tested on a large area against each other.

Sugarcane.—The trial of sugarcane varieties to find the most suitable ones for the district will be continued. A number of verieties were grown last year. Only promising ones have been retained ; others discarded. Different methods of planting have been tried this year to see what effect they may have in counteracting the present tendency of the crop to lodge. They are :—

(1) Java system of trenches and ridges ;

(2) ridging ;

(3) flat (*a*) 1′ 9″ distance.
(*b*) 1′ 0″ „

Different numbers of sets per acre have also been tried. This will be continued. Results for the year 1912-13 are not out yet.

White ants are bad on the farm. Experiments will be conducted to check their attacks. Late sowings, application of crude oil emulsion and irrigation will be tried. Sowing whole lengths of canes did not prove a success this year, as white ants instead of attacking through the sides ate up the buds.

Thick varieties will be again given a trial. They were practically a failure last year, owing to the bad attack of white ants.

Maize.—Experiments with the different methods of sowing, broadcasting *versus* drilling, drilling behind the plough, and sowing on ridges will be continued.

Cotton.—Cambodia cotton, which has proved a failure in Lyallpur, has been grown for the first time this year to find its suitability for this district. Some cottons are also grown on the farm for the Economic Botanist, Punjab.

2.—Implements.

Rajah ploughs and spring-tined harrows continued to be the main implements of cultivation. Lever harrows will be given a thorough trial for harrowing young wheat, as chain harrows have not proved heavy enough except in light land.

A cut-away disc harrow was tried for hoeing surgarcane. It is no good. A new harrow for hoeing sugarcane is expected from Ransomes, Sims and Jefferies of Ipswich, and will be given a trial.

Improved Jat plough (manufactured by Ransomes, Sims and Jefferies) will be tried to see how far it suits the Punjab soils, as the old one was very unsuitable.

3.—Cultivation.

Experiments and investigations as to the possibility of increasing the fertility and moisture capacity of *barani* soils are to be continued.

Hot weather ploughing versus rain ploughing will be tried to see the effect of summer cultivation.

Deep ploughing and shallow ploughing experiments will be continued till conclusive results are obtained. In the last two years deep ploughing has given good results.

Frequent ploughing throughout the hot weather *versus* our farm standard (one ploughing after winter rains and harrowing throughout summer) will be compared.

4.—*Inter-culture of maize and sugarcane.*

Inter-culture of maize and sugarcane sown in lines will be tried.

5.—*Harrowing of wheat.*

Harrowing of wheat after germination will be continued.

6.—*Manures.*

Bone meal for *barani* wheats will be tried again. This year it gave slightly better results.

Calcium nitrate and calcium cynamide will both be tried under *barani* conditions. Calcium nitrate was given a trial last year; two plots were treated by broadcasting calcium nitrate when the wheat was 6" high and barrowing it in. In both cases the yields of the treated plots were higher than of the untreated, but to pay the calcium nitrate would have to be purchasable at Rs. 2-8-0 the maund.

7.—*Tube well.*

A tube well with a discharge probably over half a cusec has been sunk on the farm this year to test its efficiency and suitability for Zamindars.

HANSI AGRICULTURAL STATION.

A new farm will be started at Hansi chiefly for cotton growing.

VII.—VETERINARY.

Chief Superintendent.—District work consisting of—

(*a*) *Superintendent, South Punjab.*—Inspection of hospitals :

(*b*) *Superintendent, North Punjab.*—Inspection of tonga lines, especially for glanders

(*c*) Prevention of horse and cattle diseases, especially of rinderpest, hæmorrhagic septicæmia and black quarter by inoculation and vaccination.

(*d*) Improvement of cattle breeding by advice and by pressing on the purchase of bulls, the castration of young male stock and the preservation of grazing grounds :

(*e*) Horse-breeding in non-selected districts :

(*f*) Improvement of sheep breeding by crossing with merino rams in Kangra and by selection of rams in other important sheep districts.

Pure merino rams will also be bred in Kangra :

(*g*) Attendance at cattle and horse shows.

Superintendent, Cattle Farm, Hissar.—Bull, mule, donkey and sheep breeding.

(*a*) *Camel Specialist.*—Investigation of surra.

(*b*) Life history and local distribution of biting flies :

(*c*) Advising the Commanding Officers of Camel Corps in regard to the prevention and cure of surra :

(*d*) Investigation of the disease known as sore throat :

(*e*) Investigation of influenza in camels :

(*f*) Investigation regarding the susceptibility of camels to rinderpest, hæmorrhagic septicæmia and foot and mouth disease :

(*g*) Study of anthrax in camels and effect of anti-anthrax serum :

(*h*) Study of the poisonous plants to which a large number of deaths are attributed and their antidotes :

(*i*) Determination of the amounts of the more common drugs that should be given when camels are treated for diseases such as pneumonia, rheumatism, colic, etc.

(*j*) The role played by biting flies (other than tabanidæ) *e.g.*, hæmatobia, philimatomyia, etc., in the transmission of surra in camels.

(*k*) The determination of the number of camels belonging to private owners, affected with surra.

Veterinary College—

(*a*) Teaching :

(*b*) Diagnosis ;

(*c*) Classification of parasites :

(*d*) Hæmorrhagic septicæmia in various animals :

(*e*) Epidemic pleuro-pneumonia in goats :

(*f*) The treatment of surra in horses :

All these are main lines of work.

5.—BOMBAY.

I.—GENERAL.

(W. W. SMART, I.C.S., DIRECTOR OF AGRICULTURE.)

Cotton.—Cotton being the crop which supplies the chief industry of the Presidency with raw material, is the most important branch of the work of the Department.

The aim is to improve either the quality or the quantity of the cotton by selection, improved tillage and the introduction where necessary of new varieties.

In Gujarat hybrid and selected strains of Broach cotton, giving a slightly greater amount of lint to the acre and improved staple, have been discovered by experiments on the Surat farm. The extended distribution of these cottons will be continued.

In Khandesh a prolific strain of Rosenm cotton has been found in the existing mixture used by cultivators. A farm of 200 acres has been acquired this year, and the seed produced will be distributed to registered growers who will multiply the seed for distribution throughout Khandesh where there are 1,345,300 acres under cotton.

In the Southern Maratha Country the attempt to extend the area under Broach and Cambodia cottons will be continued. Dharwar-American is a mixture of two varieties which are to be separated this year. The yield and quality of each will be studied. In Northern Gujarat the behaviour of the Cambodia seed, distributed on a small scale after testing for some years on Nadiad and Dohad farms, will be considered with a view to more extensive distribution.

In Sind the extension of Triumph American cotton seed will be continued in conjunction with the Bombay Syndicate, which is erecting ginning factories and buying centres for purchase of the cotton produced from the 40 tons distributed this season. The improvement of Sindhi cotton, by sowing the best variety and using improved methods of cultivation, will be continued.

The improvement of cotton in this Presidency is chiefly a matter of organising the distribution of good seed on a large scale and the adoption of better methods of tillage.

Sugarcane.—Many questions as to the improvement of the cultivation of sugarcane and the manufacture of *gul* by small holders have been solved, or require little further investigation. The improvements introduced may lead up to the installation of small central factories for the manufacture of *gul*, but until the proposed extensions of canals are carried out, which will be 10 years hence, the growth of sugarcane on a large scale and the ousting of *gul* by sugar manufactured in large central factories are impossible.

Demonstrations of the improved methods worked out at Manjri and the establishment of demonstration plots in the area to be commanded by proposed canals, will be taken up systematically.

Rice.—The investigations of the "rab" system of cultivation will be continued by Mr. J. B. Knight and Dr. Mann with a view to verify the results obtained and to ascertain the real cause of the advantages of the system over direct sowing; to economise the use of *rab* materials, especially lopping of trees, and to find substitutes for existing *rab* materials.

The work on the classification of rices of the Presidency will continue under Mr. Burns' direction, and after the botanical side of the work is completed, more attention will be devoted than at present to the agricultural characteristics of varieties.

Other Staple crops.—The existing work, which consists chiefly in the trial of existing varieties of the Presidency in different localities to test their yield and quality is progressing, but no great progress can be made in the absence of a second Economic Botanist to carry out breeding experiments in order to obtain a rust-resistant wheat. The introduction of foreign varieties of groundnut into other parts of the Presidency than the Deccan will be continued, and the best spacing and method of cultivating them are being investigated further.

Fruit-culture.—Mr. Burns has described in detail the work in progress or to be carried out by himself and his staff. Much systematic study of the mango, citrus fruits, papayas and grapes has been carried out. New work will be done on the canning of mangoes. The popularising of the practice of spraying grape and betel vines, and the distribution of sugarcanes free from red-rot disease will be continued.

Tillage.—The capacity of the Bajac geared plough to eradicate weeds from lands infested with "Hariali" and "Kunda" grasses has been proved. A second 2 gang plough has started operations near Surat with success. A steam plough will start work in the Dharwar district on 1st November. It has been purchased with a grant of Rs. 45,000 from the Sassoon David Trust Fund. The business management is in the hands of the Department and the mechanical details are to be arranged by Messrs. Fowler and Co. The object of the venture is, to prove that the working of steam tackle capable of ploughing black cotton soil 16" to 18" deep can be taken up as a commercial undertaking.

The value of the iron plough on black cotton soils has been approved by the cultivators. The use of other improved implements is being demonstrated or is under experiment. The improvement of indigenous ploughs, yokes, hoes, etc., is being studied with promise of good results.

Fodder.—The best method of stacking "Kadhi" or the stalks of jowar has been discovered by experiments carried out for some years.

Experiments in shredding and pressing Kadbi into bales with the chaff of pulses will be undertaken, if approved by Government. The problems involved in the cutting and storage of grass and its feeding value are being studied. The feeding to bullocks of prickly pear with 6 per cent cotton seed has been proved to be satisfactory in famine times. The use of cotton hulls as a substitute for Kadbi has been proved partially, and the experiments will be extended.

Manures.—The scope for manures, such as fish, safflower cake, ammonium sulphate, mowra refuse, nightsoil, poudrette etc., is being investigated further. Fish manure, safflower cake and ammonium sulphate as manures for sugarcane have become popular. The Department will continue to experiment with a view to discover manures which can be used with profit.

Engineering Branch.—The value of oil engines for pumping plants is being appreciated owing to previous demonstrations of their value. Mr. Musto's patent boring machine, which bores in soil and rock, is being adopted to supersede the Cawnpore apparatus. It will be used in connection with blasting and convoluted tube wells.

A workshop and training school for owners of pumping plants and the drivers of their engines is in course of construction.

Mr. Mehta's cotton seed cleaning machine is to be constructed on commercial lines and introduced on seed farms if proved to be satisfactory on further trials, which are in progress.

Civil Veterinary Department.—A revision of the pay and grades and proposals for the expansion of the Department in the districts are being submitted for sanction. An increase in the number of Veterinary Inspectors and Veterinary Assistants is proposed. The popularisation of inoculation for rinderpest has made good progress. Many points in administration have been settled in the last year, and revised rules for the College have been sanctioned.

II.—AGRICULTURE, NORTHERN AND CENTRAL DIVISIONS.

(T. F. MAIN, B.Sc.)

CROPS.

1. *Cotton experimental.*—This work will be continued on the same lines as described in previous programmes. Progress has been made on the Nadiad farm in determining a suitable cotton for Northern Gujarat where slight irrigation facilities exist. Of the numerous varieties and hybrids tested none surpass Cambodia which appears to be distinctly superior to Buri in this tract. Local Lalio, however, is a very good cotton and further comparative experiments are necessary.—

Seed supply and distribution.

(a) The scheme in which a Syndicate of Bombay agreed to purchase the *kapas* of cultivators grown from Departmental seed in Surat district at an enhanced rate of 5 per cent. over market rates proved unworkable due largely to the fact that the Syndicate directed matters from Bombay instead of on the spot. They did not follow the methods of local merchants who protect themselves from loss by selling the cotton immediately they have bought the *kapas* and before its delivery. Thus the Syndicate purchased *kapas* in February, March, April, when rates ruled high and sold it in Bombay when the market had declined and then complained that they had made a big loss. Later in the season (1912-13) they gave a lot of trouble both to the Department and the cultivators by suspending buying operations when the market was falling and the cultivators were anxious to sell. This was in connection with disputes about what constituted the local market rate for *kapas* at Surat on any one day. There are no official quotations in Surat and rates vary from village to village a good deal on the same day. Finally the Syndicate reported that they did not find the cotton superior to local cotton in any respect except ginning percentage in spite of the fact that they had sold 1,200 bales in Bombay at a rate 7½ per cent above that day's quotation for Fine Surat.

A large amount of seed has been distributed again this season, and as the local merchants appreciate the cotton and give good prices, no special arrangements for disposing of the crop will be made, beyond granting a certificate as to its origin from farm seed.

(b) In Khandesh where the superiority of Roseum cotton has been proved on the Dhulia Farm, a large seed farm at Jalgaon has been opened and steps are bing taken to organize a body of seed growers who will sow seed supplied by the Department and sell the same either to the Department or to the general public according to the terms of the agreement. In the season 1913-14 there are 13 such growers who have sown an aggregate area of 350 acres with our seed.

(c) In Northern Gujarat the distribution of Cambodia cotton seed has been conducted on a limited scale and a portion of the Nadiad farm has been set aside for seed growing purposes.

(d) In the eastern talukas of the Panch Mahals cotton is not cultivated but experiments on the Dohad farm with several varieties have proved the local conditions to be very favourable to this crop except in one respect, viz., slight liability to damage by frost. Roseum cotton which matures early and gives a very high outturn has therefore been selected for this tract and seed distribution has been commenced on a small scale.

2. *Jowar.*—At Surat selection will be continued and selected strains compared with the existing varieties. Hitherto comparative tests have been vitiated by unfavourable climatic conditions or insect pests.

3. *Wheat.*—Wheat selection will be continued with the object of increasing the yield and obtaining rust resistant strains. The work is not sufficiently advanced for noting results.

4. *Groundnuts experimental.*—As regards dry crop varieties Spanish peanuts continued to hold first place in public estimation and experiments indicate that under most of our conditions this variety does better than Japanese small. Remarkable results were obtained with Spanish peanuts in 1911-12 on the Dohad farm, where the total rainfall was only 8½ inches, yet this crop gave an outturn of over 2,000 lbs. of nuts (dry) per acre and left a profit of Rs. 127 per acre when other crops largely failed from drought or were completely wiped out by hairy caterpillars which pest apparently avoids groundnuts.

As regards irrigated varieties there seems to be very little to choose between several, but probably large Japanese is as good as any, though Virginia is also a good yielder.

Distribution.

In Khandesh there is a demand for Spanish peanuts. In 1911-12, 7500 lbs. were distributed but the failure of September rains adversely affected the outturn. The organization of the seed supply is now being considered and will probably follow the same lines as described above for Roseum cotton.

In Gujarat distribution is proceeding at a slower rate owing to the heavier nature of the soil in some parts and the ravages of white ants, but a demonstration plot in the Broach District gave an outturn of 1,629 lbs. of nuts and 4,369 lbs. of creepers worth Rs. 102 (as unirrigated crop).

5. *Tobacco.*—The weakness in the Nadiad tobacco is the low percentage of potash to total ash of the leaf. Experiments are in progress to test whether the defect can be modified and improved on. Pending a solution of this problem curing work is of secondary importance. A comparative test on a large scale (half an acre) was conducted with the American cigarette variety called "White Burley" in 1912-13. The yield per acre was 1,845 lbs. and a sample was well reported on by the Tobacco Leaf Development Company, Calcutta. Further work will be done on this variety. The general results of the manurial experiments show that a part of the heavy dressing of cowdung required by tobacco can be profitably replaced by a top dressing of castor cake, but the castor cake is said to adversely affect the strength of the leaf as judged by local standards.

6. *Other Crops.*—Bajri, maize, tur, guvar, castors and til are the principal other crops on which selection will be continued. Hitherto progress has been impeded owing to the difficulty of keeping cotton strains pure owing to the prevalence of natural cross fertilization.

7. *Fodder.*—Experiments will be continued in the methods of economy of fodder storage. Some useful information has been obtained. The feasibility of pressing and baling fodders other than grass and transporting the same to districts where fodder is scarce has been under inquiry. It appears that the Military authorities already do this and the Director of Agriculture has suggested to the Famine Committee of Bombay to take the matter up in preference to laying in reserve of grass.

TILLAGE.

The principal investigation on the Surat and Dhulia farms has been the study of deep cultivation in preparation for cotton and the tentative conclusion mentioned in my last programme, *viz.*, that black cotton soil if in clean condition cannot be advantageously ploughed with an inverting iron plough still holds good as regards the heavier types of soil.

In Khandesh where the soil is medium to light ploughing with a country plough for cotton is general but experiments indicate that where the land is clean the country wooden plough serves the purpose at least as well as an iron inverting plough, but the succeeding crop of jowar or bajri has consistently done better on the land which had been ploughed in the previous year with an iron plough as compared with that ploughed with a wooden plough and the average gain on the rotation has amounted to Rs. 4 to 5 through the use of an iron inverting plough. The general conclusion therefore is that in the cotton tracts of Khandesh there is an opening for iron ploughs even on clean land but they have a still greater value for breaking up new land or for cleaning dirty land, a condition which is very common, as for this purpose the wooden plough is very inefficient.

At Ahmednagar "Dry Farming" methods are being investigated. In 1912-13 the rainfall was only 10·3 inches and in spite of every effort to conserve as much moisture as possible by tillage operations it proved impossible to raise a crop. This investigation will be continued and the tillage operations will be supplemented with bunding and levelling.

MANURES.

The remarks made in my last programme hold good. The year 1911-12 was characterized by drought and in some parts famine and hence the conditions were unfavourable for manures on dry crops. In a normal season at Surat poudrette gives excellent results on cotton but in this one quite the reverse was the case; the vigorous crop suffered relatively very severely from the drought and the yield was much less than that obtained on the no manure plot. In this connection it is of much interest to note that the crop manured with crude nightsoil (applied in April 1911) resisted the effects of drought in a very marked manner and yielded heavily. In 1912-13, however the rains were good and increased yields as well as increased profits were obtained with several organic manures applied to cotton notably poudrette and mowra refuse. New investigations comprise more efficient methods of applying farmyard manure to the land.

IMPLEMENTS.

As the Bajac geared plough has done good work at Dharwar a new 2 gang plough has been obtained for use in Gujarat and the quality of its work has already been greatly appreciated. The particular purpose which it serves is the eradication of deep rooted weeds from the black cotton soils, the presence of which is the most serious obstacle in the way of raising good crops over very large areas. In this tract the land frequently becomes unploughable by ordinary means before the crops are harvested whereas under the same conditions ploughing with this plough is practicable. The Department is undertaking contract work with this plough.

The implements of chief importance in my charge are ploughs, chaff cutters and winnowing machines. Investigations with reference to the suitability of different makes for particular purposes are in progress.

PREVENTIVE ENTOMOLOGY.

Investigations as to means of dealing with hairy caterpillars (*Amsacta moorei*) and white ants are being continued on the same lines but definite results have not yet been obtained. Potato storage experiments were taken up at Khed (Poona district) on a fairly large scale but the results were negative owing to the absence of moth (*Pthorimaea operculella*) in the season 1912-13.

POULTRY.

At Surat Partridge, Wyndotte and White Orphington breeds have been rejected as delicate and Bhasras are now under trial.

ERI CULTURE.

Eri culture has been carried on on a large scale with the object of ascertaining its practicability for local conditions. The results are conclusive and show that this worm is too delicate for our conditions. Two very large broods were completely wiped out due to indigestion which induced a kind of "Flacherie." Moreover the rearing house expenses of 11½ annas per pound of pierced cocoons produced in the case of the broods which proved successful are too high to leave a profit when 12 annas per pound for the cocoons is difficult to realize.

PRACTICAL DISTRICT WORK.

The remarks made in my last programmes still hold good. The District staff is being increased and it has thus been found practicable to greatly increase the number of our demonstrations. A defect in many of the subordinates is their lack of knowledge of rural economy of the tracts in which they are located. Special steps are being taken to remedy this defect particularly among District Overseers.

III.—AGRICULTURE, SOUTHERN DIVISION.

(T. GILBERT, B.A.)

WORK IN PROGRESS.

Cottons.

(1) Broach Cotton in the S. M. Country

Aim.—To popularise a cotton which is proved successful in those cotton tracts of the S. M. Country where early rains are generally relied on.

Progress.—The trade, after encouraging the work for some years, are becoming impatient; they want more cotton.

Future work.—To organise the seed supply with the help of Dharwar Agricultural Association.

This cotton rapidly deteriorates in yield and quality of lint under the climatic conditions of Dharwar. These points are being studied on the Dharwar farm.

(2) Cambodia Cotton in the S. M. Country.

Aim.—Again popularisation of a cotton which has been proved successful in those parts of the S. M. Country where the majority of rain falls during the N. E. Monsoon.

Results.—Last season was not very favourable, and the work will be handicapped on this account. The cotton fetches high prices, but is at present bought practically solely by gin-owners for raising the grade of Dharwar-American. At the prices paid mill-owners have no use for the cotton in its pure state.

Future work.—To organise the seed supply.

To maintain the standard of the crop by selection on the Gadag farm.

To experiment further with time of sowing.

(3) Local Cottons.

The material obtained from former crosses and selections will be further worked with.

Aim.—To improve variously yield, ginning percentage and quality.

Results.—An *inter se* cross of Kumpta is reported to be the best (quality) cotton on the Dharwar farm and is being distributed amongst cultivators. Other strains are promising.

Future work.—The material in hand provides ample work, and nothing new will be undertaken.

Potatoes.

The experiments at Belgaum have been discontinued this year.

Results.—Italian seed is proved the most suitable for the local conditions. It is advisable to continue the present practice of importing fresh seed from Italy each year.

Jowar.

Aim.—(*a*) Variety trials, (*b*) selection of local variety for yield (*c*) demonstrations of $CuSO_4$ as a preventive of smut.

Results.—The promising varieties have been reduced to 5 in number. The $CuSO_4$ treatment has not yet attained great popularity.

Future work.—The material in hand will receive further attention. No new work will be undertaken.

Wheat.

Remarks similar to those for Jowar apply with the exception of item (*c*).

Sugarcane.

(*a*) *Manure.*—Popularisation of AmSO4 as a manure.

Progress.—This year 21 tons were sold, 13 in a single village.

Demonstration plots in cultivators' fields to show the benefit of this manure.

(*b*) *Gul boiling methods.*—Demonstrations of improved *gul* boiling methods.

Results.—Several demonstrations during the last year produced immediate results.

Future work.—The demonstrations will be extended.

Rice

The destruction of grass hoppers at Belgaum was very successful last year. This year the work is being undertaken by the Belgaum Agricultural Association.

Implements.

Encouraging the use of iron ploughs and other implements already proved successful.

The Bajac plough does good work, but probably cannot ever be a financial success in these parts.

Live Stock.

The grazing farm at Tegur is now partially stocked.

Aim.—(*a*) To demonstrate rational management, especially in the rearing up of young stock, and (*b*) to try to improve the Mallad cattle by the introduction of Mysore blood through the sire.

NEW WORK.

Groundnuts.

This is an important crop in the northern districts of my charge where foreign groundnuts are grown on a large scale.

The following facts have been established :—

(1) That the crop following Japanese or Spanish groundnut is generally poor.

(2) That the varieties deteriorate.

Aim.—A plot of 10 acres has been rented to investigate these two points. The experiments fall under two heads :—

(*a*) Manurial.

(*b*) Rotational.

The cause of the inferiority of the rotational crop is probably excessive nitrogen, possibly exhaustion of minerals.

Steam plough.

A double engine plough will arrive at Ranebennur at the commencement of the fair season :—

Aim.—To see if deep rooted weeds in black cotton soil can be sucessfully and economically eradicated.

Nature of work.—The engineering is being undertaken by Messrs. Fowler & Co. ; the scheme of working by this Department. The latter includes (1) canvassing and filing applications, (2) arranging the order of working with a view to a minimum amount of moving.

Cotton.

Dharwar American.—The ordinary crop contains two varieties, which, there is reason to believe, differ considerably in value. An effort will be made to separate these two.

General.

Permanent cultural, manurial and irrigational experiments as laid out by my predecessors on the Dharwar, Gokak and Gadag farms, will be continued. Sundry investigations of more or less importance which are devised and carried out by the junior members of the Farm staffs, call for no remarks. The Entomological Assistant continues his work of collection of pests and testing methods of control.

From the above programme it will be gathered that I propose to devote the greater part of my attention to promoting the adoption of improvements established by my predecessors.

IV.—AGRICULTURAL COLLEGE AND CENTRAL RESEARCH STATION.

(J. B. KNIGHT, M. Sc.)

Sugarcane.

The aim of the investigations at Manjri farm is to enable cultivators to produce cheaper *gur*.

Mineral manures, nitrogenous.

1. Since submitting the last programme the only mineral suppliers of Nitrogen have been Sulphate of Ammonia and Crude Nitre which have been compared with safflower cake, both gave higher outturns than the cake and the sulphate gives from Rs. 30 upward greater profits, the rise in price of Potassium nitrate has made the use of that manure prohibitive from an economic standpoint.

Nitrate of lime, Nitrate of Soda and Calcium Cyanamide have been introduced into the series since these at present promise to become Nitrogen sources at economic rates.

Potash and Phosphoric acid manures.

2. The results obtained with these manures have been largely vitiated by attacks of borer and a misunderstanding in the details of the cropping scheme, the only result being that when the Potash is given in conjunction with Phosphorus the Potash gives greater results but Phosphorus alone gives no advantage. Further trials are necessary before we can give definite answer to the question of the value of potash manure to cane for our soils. The work will be continued on the same lines.

3. Under bulky manures the value of the surplus trash has been tried with most excellent results, it being proved to be equal pound for pound to farm yard manure. Further research as to the quantity required is to be carried out. *Sann* as a green manure also supplies the humus necessary for our soils equal in value to that supplied in the 25 to 30 cart loads of farmyard manure usually put on.

4. Safflower cake from hydraulic presses is being compared with country pressed cake.

Cotton seed cake, slaughter-house refuse, fish manure and castor cake are also included in the manurial scheme more for demonstration than for experiment, but results obtained will corroborate the experiments of former years.

The manure requirements of cotton for the Deccan are under investigation at College Farm. So far nothing has surpassed farm-yard manure but potash manure gave some promise.

The development of suitable strains from the Khandesh mixture is in hand ; a strain of *Gossypium neglectum cutchica* has produced 1,404 lbs. of seed cotton ginning 29.7 per cent. Careful study of individual plants through successive generations are in progress and while too early to give great results, consistent improvement has been noted. The final selection is made every year from the ability of the seed of the plant to produce a crop rather than from the outturn of the selected plant.

Experiments with G. D. Mehta's modifications of the American method of separating cotton seed have given astonishing results which after being confirmed by another year's results will it is hoped prove of great value to cotton growing. But the wretched condition of the cotton seed samples, which represented the seed actually sown in the several districts, as to germination and vitality has led us to propose a more careful study of the methods of procuring cotton seed. Investigation as to picking, time of ginning, method of ginning and method of preserving is to be studied.

Varieties.—Broach, Cambodia, Buri and Khandesh varieties are compared on the College Farm as dry crops but Combodia and Buri do not produce paying yields. Broach has produced larger outturns here than even in Gujarat but the quality has deteriorated slightly. The quality of Khandesh varieties is slightly inferior to those from Berar. This work will be continued.

The irrigation experiments have been held in abeyance and at present there seems no reason for their resumption.

The work upon the quality of *gul* has resulted in indicating that quality is almost exclusively determined by variety, ripeness and the method of manufacture. We have standardized a method of manufacture and by experimenting with a single variety (*Pundia*) cut when it shows maximum purity of juice and using the standard method of manufacture we will test cane grown under different conditions of soil, season and manure for another year or two.

Cheaper methods of preparatory tillage for this crop are being taken up. The results by using better ploughs, harrows, cultivators and ridgers have reduced this cost by half. This is being followed up by modifying the system of planting so that the laborious and expensive operations of weeding and earthing up can be almost dispensed with and the same end secured through repeated operations of the Planet Junior. So far this line of work is very promising and besides reducing the cost of labour we conserve the moisture so that less irrigation is required.

For the last few years a considerable attention has been paid to the improvement of *gul* boiling furnaces and considerable success achieved, the present improved furnace being able to save 75 per cent of the fuel, more than half the time and ⅔rd of the labour. But there are still some points to be worked out before perfection is reached.

Cotton.

Trial of cotton available for irrigated tract of the Deccan. Broach has failed in this respect as has the American since they deteriorate in quality very rapidly. Sind cotton is to be tried. More money crops requiring less water are needed for the canal areas to rotate with sugarcane.

Groundnut.

Manure experiments are in hand on College Farm. Potash appears to be of value to the crops.

Varieties.—The Pondicheri seems to be improving as compared to the large varieties. The small varieties are not able to compete in outturn with the other types. None of the new varieties appear to be any better than those previously imported.

A large seeded variety with the habit of growth of the small kinds so that it can be harvested as cheaply has been received.

Groundnut has now been introduced at Manjri as a rotation crop with sugarcane and it is proposed to try and work out the factors as to manure, cultivation and soil which influence the quality of the nuts as to oil percentage, etc.

Rice.

Rab investigations by means of pots have been in hand for the past two years at Lonavala and the results have carried us one step further, *viz.*, that the principal value of the heat as apart from the ashes is due to biological causes.

Fodder and Feeds.

The College Farm is studying the adaptibility of several kinds of fodder crops as to season, time of growth, etc.

At the Dairy certain introduced leguminous feeds like berseem, clover and vetch are being tried.

Prickly pear feeding will be further studied. When used with 6 per cent. cotton seed it has proved that it furnishes a maintenance ration that will keep animals in good condition when not worked.

The value of cotton products is being tried.

We are in great need of some information as to the digestibility of our common food stuff to enable us to make out correct ration. An attempt to investigate them is under consideration.

The Dairy is under re-organization, which, when complete, will enable us to work out several problems in connection with the industry like comparison of different breeds, value of grading with European sires, value of silage towards keeping up continuous milk supply, and influencing the breeding season of buffaloes, causes which affect quality and quantity of milk yield amongst Indian cattle, the advantage of pasteurizing milk towards improving the retail trades, and the effect upon the bacterial content of the milk due to different methods of milking, handling of the milk, etc.

Implements.

Studies as to the efficiency of various foreign types and ploughs, harrows, etc., are in progress. Improvements of existing implements like Deccan plough, country yoke, the combs, harrows, drills and bullock hoes have received considerable attention and valuable results obtained, but further work is necessary.

V.—AGRICULTURE, KONKAN.

(V. H. Gonehalli, M.A.)

I.—*Alibag Farm.*

Main Investigation.

(*a*) *Rice.*—This farm is situated in the trap area of the Konkan Division.

Rice is the most important crop under investigation.

Green manuring.—Experiments to find out how far the fertility of rice fields in the Konkan can be maintained and improved by green manuring have been started. In the Konkan, the south-western monsoon commences early in June and rice seed-beds are sown at the end of May or early in June. The seedlings are transplanted in July. The idea has therefore been to sow green manure seeds on rice fields at the end of May and plough down the crop for manure before transplanting the fields with rice seedlings. *Sann* and *Dhaincha* have been the green manure crops selected. The soil of the Alibag farm is sticky and the green manure crops sown in the beginning of the monsoon suffer from waterlogging and do not produce sufficient quantities of green matter. The results obtained at the farm are not satisfactory.

In the case of lighter soils, however, *Sann* sown for green manure at the end of May and ploughed down in July has yielded good results. *Dhaincha* which is a very slow grower in the first two months of its growth is evidently unsuitable as a green manuring crop to be sown in May and ploughed down in July.

Experiments with both *Sann* and *Dhaincha* will, however, be continued to ascertain how far they will be suitable for green manuring rice fields by sowing the same at the end of May and ploughing down the crop in July.

There is another method of green manuring rice fields which is under investigation. *Sann* and *Dhaincha* are sown in the *rabi* season. *Dhaincha* is sown in September in the standing rice crop and *Sann* is sown with tillage soon after the harvesting of rice crop. The green crops are ploughed down when in flower and the fields are transplanted with rice seedlings in the succeeding *kharif* season. Experiments have been started to test this method of green manuring in the current year only and will be continued.

Transplanting.—The present local practice is to sow about 12lbs. of paddy seed for each *guntha* of seed-bed and to transplant about 6 *gunthas* of land with the seedlings of one *guntha* of seed-bed. Generally, about 16 seedlings are transplanted in each hole, the holes themselves being about 9" to 12" apart both ways. Experiments have been started to find out the most suitable number of seedlings to be planted in each hole. The results show 4 seedlings as the best number. Single seedling transplanting has failed. These experiments will be continued.

Manurial applications.—Experiments have been started to find out whether it will pay to apply to transplanted paddy 20lbs. of nitrogen in the form of bone-meal, oil-cakes, fish manure, mowhra refuse, rice hulls, poudrette and urine-earth. Bone-meal, fish manure and castor-cake have given good results. These experiments will be continued.

Seed Selection.—Experiments in selecting seed by plant-to-plant selection and the Japanese salt water method have been started. No definite results have yet been obtained. These experiments will be continued.

The testing of varieties.—The testing of the most common local varieties in comparison with the well-known varieties obtained from Madras and Nagpur will be started with the object of ascertaining their outturns and their suitability to this Division.

Rab.—The practice in the Konkan is to burn seed-beds with *rab*, *viz.*, branches of trees and bushes, cowdung, grass, dry leaves, etc. With the disappearance of jungles, cultivators have felt the scarcity of *rab* materials. Experiments have therefore been started to ascertain whether unburnt seed-beds with the application of oil cakes, fish manure, ammonium sulphate or urine-earth will produce as good rice seedlings as seed-beds burnt with rab. The results obtained are satisfactory and the experiments will be continued.

(*b*) Groundnut.—The two varieties of groundnut—Small Japan and Spanish-peanut—have been tried on the Alibag farm and yielded good profits. But the area available at the farm suitable for experiments in groundnut cultivation being limited, a small sub-station at Bandhan has been started where the problems regarding suitable variety of groundnut, distance of planting, manuring, and rotation will be investigated.

(*c*) *Tag or Sann as a fibre crop.*—In certain parts of the Konkan Division *Sann* or *Tag* is cultivated for fibre. As a preliminary to extending the area under this crop, the problems regarding the variety most suitable for fibre, manuring and rotation will be investigated.

Subsidiary Investigation.

(*a*) *Wal.*—The planting of *wal* by "Kuthi" or dibbling system in the standing rice crop will be investigated. At present, it is only the low-lying rice fields that are cropped in the *rabi* season with *wal* or any other pulse crop after rice is harvested. The high-lying rice fields, however, do not mature a *rabi* crop owing to insufficient moisture, if they are sown with it after rice is harvested. So, the system of dibbling *wal* in the standing rice crop of high-lying rice fields has been tried and has yielded good results. The *wal* so dibbled begins to grow before the rice crop is harvested and comes to maturity before the moisture in the field begins to fail it. By this method it is hoped to enable cultivators to take on suitable high lying lands a *rabi* pulse crop in addition to the *kharif* rice. The experiment will be continued.

(*b*) *Castor.*—Experiments will be made in dibbling castor also in the standing rice crop of high-lying lands with the object above referred to.

(*c*) *Onion.*—This crop is cultivated as an irrigated crop in the *rabi* season in certain parts of the Konkan. With the object of ascertaining the profits of onion cultivation and use of fish manure for the same, experiments were carried out. The results show that fish manure is suitable for the crop and that profits per acre are over a hundred Rupees. These experiments will be continued.

(*d*) *Cotton.*—Bourbon and Buri varieties cultivated at the Alibag farm have not yielded satisfactory results. The same will be tried at the newly started sub-station, with the object of ascertaining whether annual pruning and manuring as practised by an intelligent land owner in the south of the Konkan will make cotton cultivation in the Konkan profitable.

(*e*) *Ensilage.*—In the Konkan grass begins to flower in September. Cultivators do not cut it at that time and allow it to seed. If grass is cut in September, hay making is not possible, owing to rainy weather. With the object of ascertaining whether ensilage can be cheaply made by cutting grass in September and pitting it on high ground, an experiment was made last year with success. The experiment will be repeated this year.

II.—Ratnagiri Farm.

The area of this farm will be plotted for investigations similar to those described above and progress will be made in equipping the Farm. The Ratnagiri farm is typical of the laterite tract of the Konkan.

III.—District Work.

(1) The distribution of ground-nut and other seeds will be undertaken.

(2) Sets of improved varieties of sugarcane from South Kanara will be introduced.

(3) Agricultural shows with demonstrations will be helped.

(4) Co-operative work will be attended to, as far as possible.

VI.—AGRICULTURE, SIND.

(Gul Mahomed Abdur Rehman, *Acting.*)

In accordance with the Government Resolution No. 5881, dated the 15th June 1913, R.D., the programme has been divided into the following heads:—

(1) Work in progress.

(2) New work.

(3) Aims of the work in progress and of new work.

(4) Results obtained since the submission of the previous programme.

(5) Direction in which it is proposed to continue the work during the coming year.

(6) Main and subsidiary lines of investigation.

2. Before dealing with the above points it seems desirable to remark that any elaborate experimental work or scientific investigation are out of place in the present state of cultivation in Sind where even the ordinary rules of good cultivation are disregarded.

Agriculture here is dependent on irrigation and the type of water supply greatly determines the type of cultivation.

(*1*) *Work in Progress.*

Continuation of demonstration of—

(*a*) The value of crop rotation system with berseem and pulses as intervening rotatory crops.

(*b*) The value of Egyptian clover for fodder in Rabi and of certain pulses as fodder in Kharif.

(*c*) The cultivation of long stapled cotton on an extended scale both on the Jamrao canal and in Upper Sind.

(*d*) Practical district work.

(*e*) Shows and exhibitions.

(*f*) Agricultural education.

(2) *New Work.*

(*a*) Establishment of a seed farm.

(*b*) Fruit and vegetable gardening.

(*c*) Study of Bosi cultivation problem in Upper Sind.

(*d*) Varietal, cultural and irrigational experiments with important rice varieties.

(*e*) *Trial of various cheap and effective methods of preserving seed potato for growth in the next season and* obtaining a suitable rotation and profitable manuring for potato cultivation.

(3) *Aims of the work in progress.*

(*a*) Rotation of crops as understood in other countries is hardly known in Sind. Large tracts of occupied lands *are left bare fallow for a number of years every year. The system apart from being wasteful serves in no way the* purpose of fallowing, as the fields are left entirely untouched during the period of fallowing with the result that all kinds of bushes and jungle grow over them. Even roots and stalks of previous crops are not removed.

With the increased demand for land on account of growing irrigational facilities and consequent influx of non-Sindhis from the congested parts of the neighbouring provinces, the advantage of the adoption of rotation system in cultivating the land intensively will be immense.

(*b*) The question of fodder supply for cattle is growing serious day by day. No special crops are grown for this purpose and the cattle are either left to pick up natural grass on waste lands or are given a very meagre allowance of grain straw if such is available. The situation grows still worse in cold weather when the fodder gets generally scarce.

The value of cultivation of Berseem where irrigation water is available in cold weather and of certain Kharif pulses suitable for fodder and some Sorghum varieties capable of yielding 3-4 cuttings if sown in good time are therefore demonstrated with a view to their being taken up by the cultivators. Berseem provides 3-4 cuttings of excellent fodder and has further the advantage of keeping up the fertility of the soil.

(*c*) The local cotton is a coarse variety with a short staple; it is proposed to replace this by long stapled American cotton which is of a finer variety and fetches better price. In has further a shorter growing period than the Sindhi and can even therefore be grown on inundation canals. Its cultivation has passed all experimental stages and is now being grown extensively by cultivators on perennial as well as on inundation canals.

(*d*) Successful results of various experiments conducted on Government farms, and the superiority of improved implements such as Egyptian Plough, Norag or thresher and various water lifts over the indigenous ones, are brought home to cultivators by practically demonstrating them on sub-stations and in district by village to village touring.

(*e*) Agricultural Shows are another method of widely and easily advertising the departmental work. These are being held in several agricultural centres of the province.

(*f*) An Agricultural School has been opened at Mirpurkhas for traning Zemindars' and cultivators' sons who are expected to apply the knowledge gained at the School in improving their own lands.

Aims of New Work.

(*a*) The object of starting a seed farm is to raise locally seeds of certain imported crops of proved value and also other important seeds for distribution.

(*b*) Good varieties of fruit trees and English vegetables are being tried on all farms with a view to their being introduced into the Province. Large number of seedlings and cuttings are supplied to Zemindars and garden owners every year.

(*c*) The local Bosi cultivation is carried on on the principle of dry farming. Lands are heavily watered by about September and the moisture kept up by repeated ploughings till the wheat or oil seed crop is sown. This sowing is *generally done in the beginning of November.*

The object of Department's experiment in Bosi cultivation is—

(*i*) to see the effect of hot weather ploughing before irrigating in September the land intended for *bosi* cultivation ;

(*ii*) the number of waterings and quantity of water required to produce the necessary moisture to raise a bumper crop ;

(*iii*) comparison of local system of drilling the seed with country drill with drilling the seed with American made drill, and instead of repeated applications of plough and heavy roller to make the dry mulch, harrows and clod crusher will be used.

(*d*) Irrigation requirement of rices and other crops will be tested. Also transplanting of rice seedlings *versus* broadcasting the seed. The result of ploughing after rice is harvested, wil be compared with the rice plot not ploughed after harvest. Effect of " Dubari " leguminous crop on the succeeding crop of rice will be noticed.

(4) *Results obtained since the submission of the last programme.*

(*a*) Cultivation of berseem and American cotton has become so popular that this year 160 maunds=12,800lbs. of the former have been ordered out for distribution in the coming Rabi. 40 tons of the latter have been distributed *and about 4,000 acres of cotton are under cultivation at present. To deal with this cotton produce 2 special ginning* factories are being constructed that will buy up the produce at the quotation of the Liverpool market.

(*b*) The result of village to village touring and of demonstration on sub-stations is that the use of improved implements and of superior seeds has vastly increased. The increased demand for the former has resulted in the 2 firms spontaneously taking up the concern of manufacturing them. They are already making a very good business and are supplying the implements at the rates fixed by the Department. The latter are at present supplied from the farms but the demand is more than the supply.

(*c*) A large number of Agricultural Shows combined with classes for *zemindari* produce have been organised and are held with considerable success.

These Shows justify their existence by the amount of interest they create among the hundreds and thousands of attending Zemindars and cultivators.

(5) *Direction in which it is proposed to continue the work.*

The efforts of the Department will be confined to the continuation of the work on hand and to the beginning of the proposed new work referred to above.

(6) *Main and Subsidiary lines of investigation.*

Investigation into the methods of (*a*) preserving seed potato (*b*) combating potato moth, (*c*) Rosi cultivation problem and the like are all of equal importance and therefore no distinction can be made between main and subsidiary lines.

VII.—AGRICULTURAL CHEMISTRY.

(HAROLD H. MANN, D.Sc.)

Investigations of the first Importance.

1. *The Rab system of Rice culture in Western India.*—The progress in the work on this subject to 1911, and the purposes for which it was undertaken are explained at length in a memoir on the subject published from Pusa. Since that time considerable progress has been made with the investigation,—especially in connection with tracing the causes of the beneficial effect of the *rab* treatment to the change which it induces in the physical character and in the biological character of the soil. The methods of obtaining the same results by heating independently of the use of *rab* material, by the use of ashes with and without heating of the soil, by the use of other methods of altering the physical condition of the land, are all being investigated,—while the effect of the *rab* treatment and its accompaniments on the various classes of bacteria in the soil is being undertaken. The object of this work is, in the end, to devise a substitute for the present very wasteful *rab* system, and, in the alternative, to find a more economical method of carrying out the *rab* process.

2. *The constituents of Betel Vine Leaf, and their variation, together with a study of the Commercial bleaching of the Betel Vine Leaf.*—The Betel Vine is the most important garden crop in India, and very little study has been given to it hitherto. I have hence considered that the question of the improvement of this cultivation, and of the after treatment of the leaf, is worthy of extended investigation. The object is to improve the methods of cultivation and of preparation in vogue, and produce a higher quality leaf.

A first memoir is now in the press on this subject, but the work is still going on vigorously. The connection of the high development of essential oil with high quality is now proved, and the step now being chiefly worked at is how to secure that the leaf gathered shall contain the maximum of essential oil, and how the after treatment shall increase it to the greatest extent. For the present position I would refer to the memoir which will, I expect, be out before the meeting of the Board of Agriculture.

3. *The Salt Lands of the Irrigation Areas of the Bombay Presidency (excluding Sind).*—Some time ago a Bulletin was issued describing the Salt Lands of the Nira Valley, their characteristics, and their difficulties,—and it is evident that the black soil areas, when they develop salt, have their own problems. The actual problem is, of course, with the very large extension of irrigation canals in our black soil areas, to ascertain how far the development of salt land and barrenness can be prevented and cured. The position of this work, now, is chiefly to see how far the drainage methods recommended in the Bulletin above referred to are applicable and can be applied on a large scale. This is being and to be carried out in conjunction with the Irrigation Department.

4. *The composition of well waters in the trap areas, in use for irrigation, and their variation.*—The whole question of well waters, and their composition is of great importance in the trap areas, where much of the soil is continually spoiled by the use of unsuitable water for irrigation. Hence, over and above a general survey of well waters, certain places have been selected where monthly analyses of water from certain wells have now been carried out for some years. Their variations have thus been closely studied, and some results as to the causes of these variations made out. A paper on this subject is practically ready for publication.

5. *Questions relating to milk supply and Ghee manufacture.*—These inquiries are the direct continuation of the inquiries originally commenced by Mr. Meggitt when here on the variation in the composition of the milk of Indian cows and buffaloes. Two memoirs have been published on the subject, and now the following questions are especially under inquiry,—the character of the proteids of buffalo milk ; the manner of keeping buffaloes and its effect on the milk ; the production of *ghee* and its improvement. A more complete knowledge of these and many other questions seems very urgently needed where the chief milk supply is from buffoloes.

Investigations of smaller importance at present.

1. *The Nature, Properties and more wide Utilisation of Safflower Oil.*—Safflower is one of the principal dry land crops in the driest areas of the Deccan. The oil seems to be capable of much wider utilisation than it has hitherto had, as it is one of the best of the drying oils. Very considerable enquiries have been made into the boiling of safflower oil, both alone and mixed with linseed oil. The results which seem to indicate much promise for this as a drying oil will shortly be published.

2. *The deterioration of cotton seed as a source of oil when stored under Indian conditions.*—This was a question rising out of difficulties in a large factory. Cotton seed rapidly deteriorates when stored at a high temperature, the oil losing very much more than it ought on refining. This can probably be met by very careful drying before storage,—and it is hoped to publish a short paper on the subject very shortly.

3. Various other problems in connection with the developing oil-pressing industry of Western India, such as the rapid deterioration of the camel-hair cloth used in pressing, and so on,—most of which problems have been brought to my notice by the owners of mills.

4. The acid secretion from growing *gram* (*Cicer arietinum*) plants. This is almost entirely *malic* acid, as we have shown here, and has possibilities of commercial development as a source of that acid.

Over and above these things, there are always a number of minor investigations going on in my laboratory mostly for the solution of problems brought to my notice by some members of the agricultural public.

VIII.—ECONOMIC BOTANY.

(W. BURNS, B.Sc.)

(*Items in italics are new works.*)

WORK ON FRUITS.

Main lines of work are—

(*1*) *The Economic Botanist, the Curator, Bassein Garden (P. G. Joshi) and a Graduate Fieldman (S. H. Prayag, B. Ag.).*—Study of the varieties, propagation, culture, *packing*, and *canning* of the mango.

(2) *Assistant Economic Botanist (H. P. Paranjpye, B. A.).*—Study of the effects of various stocks on all the citrus varieties locally grown, testing of different manures for citrus trees.

(3) *Graduate Fieldman, (L. B. Kulkarni, L. Ag.)*—Collection, propagation, and crossing of plants with a view to the production of a seedless guava.

(4) *Graduate Fieldman (L. B. Kulkarni, L. Ag.)*.—Breeding of papaya with the view of producing a race with large sweet fruits and a large proportion of female trees.

(5) *Economic Botanist and Assistant Economic Botanist (G. B. Patwardhan, B.Sc.)*.—Classification of the local grape varieties. Improvement of local cultural methods of grapes.

(6) *Assistant Professor of Botany (H. M. Chibber, M. A.)*.—Investigation of the phenomena of seedlessness with a view to the production of seedless varieties.

Subsidiary lines of work are :—

(7) *Assistant Economic Botanist (G. B. Patwardhan, B. Sc.)*.—(1) Testing of various sprays for preventing attack of Virochola isocrates on pomegranates.

(8) *Graduate Fieldman (L. B. Kulkarni, L. Ag.)*.—(2) Experimental pressing of figs to see if the local fruit can be packed commercially in this way ; *Classification of local figs.*

(9) *Curator of Bassein Garden (P. G. Joshi) and Assistant Economic Botanist (G. B. Patwardhan, B.Sc.)* —(3) Classification of plantain varieties.

Work on Plant Diseases.

Main lines of work are—

(1) *Economic Botanist and Assistant Economic Botanist (G. B. Patwardhan, B.Sc.)*.—Popularisation of Bordeaux spraying for grape vine mildew in collaboration with district staff.

(2) *Assistant Professor of Mycology (S. L. Ajrekar, B.A.)*.—Study of *Rhizoctonia* in all plants in which it occurs.

(3) *Assistant Mycologist (G. S. Kulkarni, L. Ag.)*.—Popularisation of Bordeaux spraying for "Koleroga" disease of betelnuts in collaboration with district staff, and study of the distribution of the disease.

(4) *Assistant Mycologist (G. S. Kulkarni, L. Ag.)*.—*Study of a Fomes in Supari Palms.*

(5) *Assistant Mycologist (G. S. Kulkarni, L. Ag.)*.—To make observations on the smut of sugarcane ; to continue and complete the study of the distribution of the red rot of sugarcane.

(6) *Economic Botanist and Graduate Fieldman (S. H. Prayag, B. Ag.)*.—To continue and complete a research on the malformation of the mango inflorescence with a view to finding a remedy for the disease.

Subsidiary lines of work are :—

(1) *Assistant Professor of Mycology (S. L. Ajrekar, B.A.)*.—The study of castor rust.

(2) *Assistant Professor of Mycology (S. L. Ajrekar, B.A.)*.—The study of Cephalosporium and Glœsporium diseases of Papaya fruit.

(3) *Assistant Mycologist (G. S. Kulkarni, L. Ag.)*.—The observations of smuts of Jowar and Bajri.

(4) *Assistant Mycologist (G. S. Kulkarni, L. Ag.)*.—The study of Haplophragmium ponderosum and Aecidium esculentum on Acacia species.

(5) *Assistant Professor of Mycology (S. L. Ajrekar, B.A.)*.—The study of a Uredine on Jasminum officinale and Jasminum malabaricum.

(6) *Curator of Bassein Garden (P. G. Joshi)*.—*Investigation of local methods of coconut culture with a view to their improvement.*

Work on Fodders.

Main line of work—

(1) *Assistant Economic Botanist (R. K. Bhide) and Graduate Fieldman (L. B. Kulkarni, L. Ag.)*.—To continue testing wild fodder plants especially with a view to renovating common lands with more valuable and drought resisting species.

Work on Rice.

Main lines of work—

(1) *Assistant Economic Botanist (R. K. Bhide)*.—To continue the study of rice varieties grown in pure line cultures.

(2) *Assistant Economic Botanist (R. K. Bhide)*.—To examine the effect of different environments on varietal characters.

(3) *Assistant Economic Botanist (R. K. Bhide)*.—To study the effects of artificial hybridisation.

Other work.

Subsidiary lines only—

(1) *Graduate Fieldmen (L. B. Kulkarni, L. Ag.) and (S. H. Prayag, B. Ag.)*.—To continue the observations on hedge plants.

(2) *Assistant Professor of Botany (H. M. Chibber, M.A.)*.—To observe field conditions of the pollination of castor and Jowar.

(3) *Economic Botanist*.—To complete the classification of the Jowars of the Presidency.

(4) *Assistant Economic Botanist (R. K. Bhide)*.—To make and classify a collection of weeds and weed seeds.

Teaching.

Main lines of work are :—

(1) *Economic Botanist and his two Assistant Professors*.—Teaching of 1st, 2nd and 3rd year College students.

(2) *Assistant Professors, one Graduate Fieldman*.—Teaching of Short Course students.

(3) *The Assistant Economic Botanist, and 2 Graduate Fieldmen*.—Teaching of special horticultural students.

Subsidiary :—

(1) *The Assistant Economic Botanist, and 2 Graduate Fieldmen*.—Teaching of *malis*.

(2) *The Assistant Economic Botanist, and 2 Graduate Fieldmen*.—Assistance in teaching of vernacular school boys.

(3) *Economic Botanist*.—I.C.S. course.

Below is given an account of the work done since the submission of last programme.

1. *Fruits.*—Since the last programme was submitted (to the Board of Agriculture, in November 1911) definite results have been attained as to the best methods of grafting and budding the *mango*, *renovation* of neglected mango plantations, general treatment of mango plantations, and packing and transport of mango fruits and scions. The comparative value of various stocks for citrus varieties is becoming apparent. Crossing of mango varieties and citrus varieties has so far failed. Collections and descriptions of mango, guava, and plantain varieties have been made. Useful facts have been collected as to the germination of papaya seeds, the proportion of bearing trees and the comparative value of the Ceylon and the local papaya, and the effect of thinning papaya fruits. Improvements of the local methods of grape culture have resulted in excellent fruits in the second year from planting.

Manurial experiments on grapes and citrus have been begun.

2. *Diseases.*—Since the submission of the last programme the following results have been achieved :—(1) Spraying with Bordeaux mixture plus soap has reduced the number of mildewed bunches in vineyards from 68·8 to 9·7 per cent. The process of spraying is now being taken up by the growers. Castor rust has been described and germination of its spores tested. The papaya disease was shown to be associated with a Glœsporium. The general relation between the telouto and æcidial forms of Cystopsora oleæ was established. The smuts of jowar and bajri have been closely investigated and it seems likely that the species will have to be reconsidored. The survey of the areas affected by red-rot of sugarcane has been nearly completed. The introduction with success of disease-free canes has been carried out. The conidial stage of the leaf ear disease of *Jowar* (Sclerospora graminicola) has been discovered. The "Tikka" disease of ground-nut has practically disappeared. The study of the progeny of selected Tur plants for wilt resistance has been continued and numerical results obtained. Experiments with rust resistant wheats have been abandoned. One year's experiments in spraying Betelnut palms for Koleroga (*Phytophthora omnivora* var. *Arecae*, Coleman) have been successfully concluded. A large number of facts have been collected regarding a malformation of the mango inflorescence, and the morphology, physiology and anatomy of normal and abnormal inflorescences studied.

Abnormalities of plant structure have been studied and described.

Rhinocladium corticolum on mango branches was studied and its association with a coccid insect proved.

Miscellaneous.—Since last report about forty wild fodder plants and several foreign cultivated ones have been tested as to growth, seeding, drought resistance and results have been obtained on these points. Seeds were collected and green manuring experiments made with *Sesbania aculeata*. It proved too slow growing for rice manuring. *Acacia arabica* and *Acacia farnesiana* have proved the best irrigated and non-irrigated hedge plants if properly pruned. An exhaustive study of the morphology, anatomy and cultivation of Piper betle has been made. Trapa bispinosa has been introduced and grown in tanks for this Presidency.

Many other plants of economic value have been introduced and grown under observation.

The study of the rice varieties of the Presidency has shown that many so-called early and late varieties have changed their characters or are not correctly so termed. Accurate notes and measurements have been taken on characters to be used for classification. The production from a red grain of panicles containing white seed has been proved.

Demonstrations and lectures chiefly on fruit culture and plant diseases have been given. Many tours have been made to advise, on the spot, landholders who applied for guidance.

Testing of seeds of cultivated plants from a large number of villages has been carried out to obtain facts as to the quality of the seed used in staple crops. Collection and testing of weed seeds has been carried out. Teaching of F. Ag., S. Ag., & B. Ag., and Short Course students, Pupil fieldmen, Malis, Vernacular School boys, and special students has been carried on.

IX.—VETERINARY.

(K. Hewlett, M.R.C.V.S.)

(a) *Veterinary College.*

The programme of work at this College during the year 1914-15 will consist of educational work in the College, professional work in the Bai Sakerbai Hospital and diagnostic work in the Laboratory. In addition to this the Principal will continue to control the Glanders and Farcy Department and act as Practitioner under the Glanders and Farcy Act for the City of Bombay and Bandra.

2. Investigation work is not carried on in this College pending the appointment of the Pathologist and the construction of the new contagious disease hospital and laboratory.

(Lieutenant-Colonel H. M. Maxwell, F.R.C.V.S.)

(b) *Superintendent, Civil Veterinary Department.*

The current year (1913-14) being the last of the five years for which the scheme for the development of the Subordinate Civil Veterinary Department was sanctioned by Government, recommendations for further expansion, to extend over a further five years, have been submitted to Government.

2. Great difficulty being experienced owing to shortage of men it has been suggested to raise the present cadre of 57 to 100, by the end of the 5th year.

3. Suggestions for improved pay and promotion in the junior ranks have been put forward.

4. In order that a dispensary may not be closed when the Veterinary Assistant in charge goes on tour in connection with out-breaks of contagious diseases, it has been found necessary that every dispensary should have a Compounder. The question of how best to get these men trained is to be considered.

5. I would propose that each year one Inspector be sent to Bareilly to undergo a three months' course in elementary Microscopy and Bacteriological work. This could be done in the months of July, August and September when but little touring is done.

6. To consider whether preventive inoculation against Anthrax, Septicæmia Hæmorrhagica and Black Quarter should not now be introduced under the direct supervision of the Superintendent, Deputy Superintendent or Divisional Inspectors.

7. Inspectors to be instructed to extend their inspection into all villages served by a dispensary so that they may become personally acquainted with the people and be able to report from their own observations the value of the work done by the Veterinary Assistant. Too much inspection work is done, and reports made from book entries alone.

8. Improvement of cattle-breeding.

9. Improvement of horse-breeding.

10. Storage of fodder.

6.—MADRAS.

I.—BRIEF SUMMARY OF WORK IN THE PRESIDENCY.

(D. T. CHADWICK, M.A., I.C.S., *Director of Agriculture.*)

District Work.

Main Lines—Work in progress—(1) *The economical transplantation of paddy.*—This system is now being tried to a greater or less extent in most districts. It is now adopted over several thousands of acres and as it is profitable its adoption will be further advocated.

(2) *The cultivation of green manure crops on wet lands.*—This practice is also spreading. Green manure seeds are being grown for the Department under contract to meet expected increased demand.

(3) *The spread of pure and improved strains of cotton in Tinnevelly, Bellary and Kurnool districts.*—The results in Tinnevelly therefrom have already been noticed. Considerable progress was made last year in Kurnool. Over 130,000 lbs. of seed were sold. Efforts are being made to induce villagers in Tinnevelly to take steps to ensure the continuance of a pure seed supply.

(4) The introduction of better canes and improved methods of making jaggery into the West Coast districts.

(5) The use of the drill and harrow for cultivation purposes in Tinnevelly.

Work on all these is bearing fruit in the districts. The rate of progress in all districts is not equal owing to local conditions and lack of staff, etc. In the following main line of work progress in the districts is not so rapid.

(6) The use of green manure crops *plus* phosphate as a manurial substitute for the old village earth in the delta of the Kistna.

(7) Checking the evil practices of mixing cotton of different grades, of not picking Cambodia cotton clean, of neglecting rotations when dealing with groundnut. The prospect of immediate profits proves too alluring and encourages improvident practice.

(8) The use of the deep soil plough on black cotton soils.

Measures against Disease.—Where the area infected is small, these are done by the Department, where large, either by the district staff or by a special staff under advice from the Department.

(9) The palmyra bud rot in Gōdāvari and Kistna. The area infected in Kistna is less than previously but the disease is still severe in Gōdāvari.

(10) The operations against *Mahali* have been entirely successful. Some ryots have enquired about buying spraying machines for their own use.

(11) Some cocoanuts in Malabar are suffering from the Gōdāvari palm disease. The area infected is not yet accurately known, but it is not expected to be very large.

(12) The Entomological field staff are in the villages at work against the Deccan grasshopper.

Subsidiary lines of work comprise—(I do not attempt to give them in detail)—

(1) The sale of selected paddy seed and varieties of cane and groundnut.

(2) Cultivation of onions from seed.

(3) *Cultivation of ragi on ridge and furrow.*

(4) A cattle survey has been made by Mr. H. C. Sampson and the papers are before the Government.

TEACHING.

A revised syllabus has been drawn up with a view to making the course at Coimbatore more practical in the earlier stages and permitting a larger attendance at the college. It is proposed to ask the opinion of the Board of Agriculture thereon.

RESEARCH.

The several officers have submitted their programmes. A very important line of work is that outlined by Mr. Harrison. Green-manuring for paddy is being advocated in the districts and it is essential that more be known of its action in different soils.

The Sugarcane-breeding Station has been opened and Dr. Barber has succeeded in raising a large number of seedlings which are being examined in detail.

II.—AGRICULTURE, NORTHERN DIVISION.

(G. R. HILSON, B.SC.)

Hagari Agricultural Station.

Dry Area.

Main Lines—Work in progress.—The main line of work, *viz.*, the improvement of the three main black soil crops of the district, cotton, sorghum and Italian millet, will be continued.

So far, most progress has been made towards the object aimed at in the case of the first-named crop, and a strain has been obtained which is an advance on the local cotton in point of whiteness, softness, length and percentage (by $2\frac{1}{2}$ per cent.) of lint, and which is a fair yielder, though neither in this respect nor in strength of lint is it very different from the local cotton.

As regards the grain crops sufficient time has not elapsed to permit a decision to be arrived at as to whether the selections already made are an improvement or not.

Subsidiary Lines—(*a*) *Work in progress.*—The following subsidiary lines of work will be continued: (1) Manurial experiments with cattle manure, sheep manure and magnesium sulphate. These experiments were started with the object of testing the effect of these manures when applied directly to the cotton and sorghum crops, but last year an alteration was made in the arrangement of the plots in the case of the first two manures in order to obtain comparative data for their effect when applied directly and indirectly, *i.e.*, through a grain crop to cotton. (2) The continuous cultivation of Italian millet on the same plot. This experiment is devised to discover whether the yield of this crop when grown in this way will decrease and, if so, why. (3) Rotation experiments with cotton, sorghum,

Italian millet and Bengal-gram. These were started last year and are devised to test whether the local rotation would not benefit by the introduction of a pure leguminous crop, and to obtain definite comparative data for the yields of these crops when grown pure and when grown mixed according to local practice.

(*b*) *New work.*—(4) A cultivation experiment with groundnut and Italian millet sown mixed to test whether the mixture will prove satisfactory in this district, the object being, if it proves so, to introduce the practice into the district as the cultivation of the former crop is spreading rapidly to the detriment of the area under grain crops. (5) The collection of specimens and seed, and the sowing of small plots, of the local grasses in order to obtain some definite information about them.

These two last lines of work will be begun this year.

Garden.

Main Lines—Work in progress.—The following lines of work started last year will be continued: (1) The improvement of the ragi crop by selection; (2) cultivation experiments with this crop to test the ridge method of planting against planting on the flat and to discover what is the best seed rate to adopt for sowing seed beds; (3) the same as (2) but with onions instead of ragi; (4) the improvement of the chilly crop by selection.

Subsidiary Lines—(a) Work in progress.—A cultivation experiment to compare the single planting of chilly seedlings with double planting. (2) A manurial experiment with super-phosphate to test the effect of the application to garden crops of this manure with green manure against green manure alone. (3) The comparison of different leguminous crops as green manures. (4) The comparison of different varieties of sugarcane.

The following work will be begun this year.

(*b*) *New work.*—(5) An experiment with groundnut and ragi similar to that to be tried in the dry area with groundnut and Italian millet.

The Uncultivated Area.

This area is now fairly well covered with vegetation and the work of gradually improving it will be continued.

Sheep.

Main Lines—Work in progress.—A small flock has been got together and is grazed in the above area. An attempt will be made to establish a black-faced white wooled breed and at the same time an endeavour will be made to improve the wool bearing qualities of the breed by selection, the final object being to raise both the quality and the quantity of wool produced in the district. The flock is small but so far promising.

Nandyal Agricultural Station.

Main Lines—Work in progress.—The main line of work, *viz.*, the improvement of the cotton and sorghum crops which are the two main black soil crops in this district, will be continued. As at Hagari most progress has been made with the former crop. The remarks made above with regard to this crop apply here except that the increase in percentage is just double that obtained at Hagari, *i.e.*, a strain giving 30 per cent. of lint to *kappas* has been obtained.

The remarks made above with regard to the grain crop apply without exception.

Subsidiary Lines.—(a) Work in progress.—The following subsidiary lines of work will be continued. (1) Manurial experiments with cattle and sheep manure as at Hagari. (2) A cultivation experiment with cotton and horse-gram devised to test the yield of the former when grown mixed with the latter as is done locally, as compared with its yield when grown pure and also to test whether the horsegram has any effect on the succeeding sorghum crop. (3) Rotation experiments with cotton, sorghum, Bengal gram and indigo to test the following rotations against one another—cotton and sorghum cotton, sorghum and Bengal gram; and cotton sorghum and indigo. This is the old "Indigo as green manure" experiment altered in form.

Samalkota Agricultural Station.

WET LAND.

Main Lines—(a) Work in progress.—The following main lines of work will be continued: (1) The improvement of the paddy crop by selection. (2) The testing of varieties of paddy obtained from the districts of Kistna, Guntūr and Gōdāvari. (3) Cultivation experiments with this crop to discover (*a*) the optimum seed-rate to adopt in sowing seed beds, (*b*) the best age at which to transplant, (*c*) the best spacing to adopt in planting, attention being paid to the quality of the land, (*d*) whether it is better to cultivate the land in the dry season or to leave it uncultivated. (4) Manurial experiments to compare (*a*) a complete manuring against the same manuring with an addition of paddy straw, (*b*) the application of castor cake alone against its application combined with a potassic and a phosphoric manure, (*c*) as (*b*) but with green manure in the place of castor-cake, (*d*) the three green manures, sesbania, sunnhemp and teega pesalu (*Phaseolus mungo var*) with one another.

As regards selection work the only result obtained so far is that it has been found that cross fertilisation in paddy takes place and has to be guarded against, but that if sufficient space is left between each plot this will not be a difficult matter. The results obtained from the cultivation experiments show that the local seed-rate is excessive, that single planting is more economical than planting two seedlings per hole, and point to the conclusions that it appears to be immaterial whether the seedlings are 25 or 45 days old provided they are planted at the proper season, and that cultivation of the soil in the dry season causes a reduction of yield. As regards the manurial experiments the results obtained show that sulphate of potash and sulpha[illegible] of ammonia are not economical manures for this crop and that the most satisfactory manuring for the crop appears to be an organic manure such as castor-cake or green manure combined with a phosphoric manure such as superphosphate.

(5) Ridge-planting of sugarcane. (6) Manurial experiments with cattle manure and different oil-cakes. (7) The testing of different varieties of sugarcane.

Cultivation experiments with this crop have shown that planting on the flat gives the most satisfactory results on this land and manurial experiments have shown that chemical manures are not economical.

(*b*) *New Work.*—The drainage experiment which has so far been under tentative trial will be extended and taken up definitely. Two plots will be laid out both of which will be surrounded by a trench. water will be supplied to the plots over the trench but in the case of one plot as long an interval as possible will be allowed to pass between each watering and in the case of the other only short interval of two or three days will be allowed during which there will be no water standing in the field and the soil will not be allowed to crack. The first plot will be divided into two, one half will be left unmanured and the other will receive an application of 3,000 lbs. of green manure and 1 cwt. of superphosphate; the other plot will receive a similar manuring.

Subsidiary Lines—(a) Work in progress.—The maintenance of a stock of different kinds of useful cane for distribution to other centres when needed.

(b) *New work.*—The following work will be begun this year :—

(1) The testing of different varieties of paddy planted in August-September with the object of discovering one which will yield satisfactorily when planted at this time. This experiment has been devised with reference to the conditions prevailing in Kistna and Guntur districts where most of the land is single crop land and where it is the custom to grow sunnhemp after the paddy crop for fodder. The object of the experiment is to see whether a green manure crop could not be grown before the paddy crop.

(2) An experiment to discover whether it would not be possible to grow a short term paddy first at the break of the monsoon instead of a long term paddy as is done at present and follow this with a longer term crop which would be ready for harvest in April. This is an alternative to the experiment which is being tried of planting the short term paddies a month earlier than usual and which has not yet yielded any satisfactory results and which will be given up if this year's results are similar.

Anakapalle Agricultural Station.

(*Station now being opened.*)

Main Lines—(a) *New work.*—Selection work in paddy, ragi and sazza (*P. typhoideum*) and testing of varieties of these crops and of sugarcane will be begun.

Sirvel Agricultural Station.

(*Land for it only recently selected.*)

Main Lines—(a) *New work.*—(1) The economical conversion into wet lands of light dry soils similar to those commanded by the proposed Velgode Irrigation Project.

(2) A system of cheap manuring for such wet lands suited to the peculiar local conditions.

District Work.

Main Lines.—(a) *Work in progress.*—(1) Cotton improvement work in the districts of Bellary and Kurnool will be continued on the same lines as before. In both districts the work has resulted in an increased demand for white cotton and higher prices are given for cotton which is known to be the produce of seed obtained from Hagari and Nandyal farms.

(2) The work of demonstrating the use of an economical manurial substitute for old village earth will be continued in Guntūr district. The ryots are tentatively trying this substitute in the adjoining delta of Kistna district.

(3) Green manure work will be continued in the districts of Godavari, Kistna and Chittoor and will be extended nto the neighbouring districts to these.

(4) Single planting of paddy will continue to be advocated wherever officers of the Department are working and paddy is grown. This is being adopted in different places.

(5) The introduction of Cambodia cotton into the Circars will be continued and in Godavari district row planting of sugarcane will continue to be advocated.

(b) *New work.*—Endeavour to check the bad practice of cultivating groundnuts repeatedly on the same land.

Subsidiary Lines.—Advise so far as possible on questions brought to notice by ryots.

III.—AGRICULTURE, SOUTHERN DIVISION.

(K. Ram Sastrulu, *Acting.*)

General.

The work in the Southern Division consists of the management of the four agricultural stations at Palur, Manganallur, Koilpatti and Taliparamba, controlling the work outside the stations such as the cotton improvement work in Tinnevelly district, green manure work in Periyar Delta and single planting or economic planting of paddy in the east and west coasts of the division. All this work is at present being managed by one Deputy Director of Agriculture, assisted by an Assistant Director. The work of the latter chiefly consists of visiting big *mirasdars* or landholders and giving them advice on agricultural matters. He also acts for the Deputy Director of Agriculture when the latter happens to be either on leave or on other duty. At times he will be in charge of the green manure seed supply or any other miscellaneous work wherein the Deputy Director requires assistance.

District Work.

The main lines of work—(a) *In progress*—(1) *Cotton improvement work in the Tinnevelly district.*—This work is in connection with the indigenous cottons. Both Karunganni and Uppam are being tried. As Karunganni cotton offers better scope for improvement than the other variety the selection and improvement work is mainly done on Karunganni. The work on the farm consists in the selection of individual plants of good strains, growing these selections on a larger scale for the second year and continuing the same on a greater scale during the third year and finally putting them on to special seed farms in cases in which they have maintained their characteristics. By this means some strains of pure Karunganni of very good quality have been obtained. One of these now grown on field scale continues to give 28 per cent. of lint to seed which is well above the district average. It is also of good quality. Pure Karunganni seed is raised by ryots on seed farms under contract and sold in numerous village depôts in the next season. In order to extend this work of distribution to other centres an attempt is being made to induce the ryots of villages where pure seed has been distributed in the past to take their *kappas* direct to the ginneries without the intervention of the middleman. The cotton firms have undertaken in such cases to gin such *kappas* immediately in specially and carefully cleaned gins and return the seed at once to the villagers. If this practice can be established it is hoped thereby to check the mixing of seed which now takes place and thereby ensure a continuance of good seed in those villages in which pure Karunganni has been distributed. Four villages have done so this year on a small scale.

The introduction of drill cultivation in connection with cotton improvement work is becoming more and more appreciated and work in this direction will have to be continued.

(2) *Green manure work.*—Owing to want of sufficient number of officers the work in this direction has been limited to the Periyar tract in Madura district. The practice which is distinctly profitable is spreading steadily in this tract and is being adopted in other districts also. Arrangements are being made to ensure larger stocks of green manure seeds for the ensuing season. This will continue to be advocated in all districts possessing well drained paddy soils.

(3) *Single or economic planting of paddy.*—This practice is spreading widely, especially in South Arcot, Tanjore Madura, Tinnevelly and the West Coast. It is being advocated in Coimbatore. In Malabar by the aid of the District Agricultural Association a certain number of village associations have been formed composed of cultivators who are attempting this practice under advice from the Agricultural officers on their own lands. This work will be continued.

(4) Cultivation of groundnuts with cereals or in rotation with cereals.

(5) *Use of iron mills for crushing cane and pans for boiling jaggery on the West Coast.*—Practice is spreading due to efforts of the staff at Teliparamba.

(6) *Introduction of Red Mauritius and B. 208 instead of local varieties on the West Coast.*—The demand for these better varieties is increasing.

(*b*) *Subsidiary Lines—Work in progress.*—(1) Introduction of fish manure for garden and wet lands.

(2) Sale of implements.

(3) Introduction of growing onions from seed in Tinnevelly. Progress is encouraging.

(4) Cultivation of ragi on ridge and furrow.

(5) Answers to enquiries for advice, etc.

Koilpatti Agricultural Station.

Main Lines—Work in progress.—(1) *Cotton improvement.*—*To produce strains of pure* Karunganni of better quality and colour with higher percentages of lint. Progress already described briefly.

(2) On the garden red soils of the farm, selection work *has commenced on Cambodia cotton with* a view to see whether it is possible to improve the quality of the cotton begun and prevent deterioration. A few plants have been selected and the seed therefrom will be sown separately this season. The cultivation of this cotton has spread widely and complaints of deterioration are heard. These are often the results of inferior cultural practice.

(3) Introduction of Periamanjal *cholum* both as a fodder and grain crop has not given any decided results. This work will be continued by selecting strains of Periamanjal *cholum* which may become a successful grain crop.

Subsidiary Lines—Work in progress.—(1) Mixed cropping trials with cotton as well as with *cumbu* will be continued. Mixing *cumbu* with pulses proved profitable. Cotton as a pure crop is more likely to be profitable than as a mixed crop.

(2) *Onions.*—Growing of seed to meet increasing demand.

Palur Agricultural Station.

Main Line—Work in progress.—(1) *The testing of varieties of ground-nut.*—Results which are not very decisive are in favour of the local Mauritius. These also will be continued.

(2) *Cultivation of ground-nuts as mixed crop with cereals.*—Results indicate that this practice is decidedly profitable. Will be continued.

(3) *Sugarcane—Testing of varieties.*—Decisive results have not yet been obtained.

(4) *Paddy.*—Improved by selection which is promising. All will be continued.

Taliparamba Agricultural Station.

Main Lines—Work in progress.—(1) *Paddy.*—Economic planting, seed selection, thin sowing and green manuring with cowgram prove successful. All these are being demonstrated on the farm and will be continued.

(2) *Sugarcane.*—The growing of red Mauritius and B. 208 which are suited to the West Coast.

(3) *Pepper.*—It is found that pepper when heavily manured with fish, leaf mould and lime succeeds well. Particular attention will be given to investigations of this kind.

All this work will be continued.

(4) *Dry land.*—Introduction of paying crops like turmeric, ginger, chillies and peas, etc., into the dry land of the farm to find a successful scheme whereby ryots can regularly utilise their dry lands.

Manganallur Agricultural Station.

Main Lines—Work in progress.—This is a new station. It was only opened last year for work on paddy, *viz.* (*a*) selection of seed, (*b*) to devise a cheap system of manuring suitable for the fine heavy delta land. Last year's work showed that green manure crops require different handling on such soil.

IV.—AGRICULTURAL COLLEGE AND CENTRAL RESEARCH STATION, COIMBATORE.

(H. C. Sampson, B.Sc., F.H.A.S., F.B.S.E., Ag. Principal.)

Main Lines—Work in progress.—(1) The diploma course will continue as heretofore as far as the present students are concerned. The future course, the scheme for which will be laid before the next meeting of the Board of Agriculture, will depend upon its decision and, if accepted, it will follow the lines outlined in the programme for 1913-14.

(2) The agricultural station will continue to be treated mainly as a training ground for students and the demonstration of improved methods of cultivation, etc. *It is incorporated in the general working of the farm.*

(3) Arrangement to give practical training in improved agricultural practice to the cultivating classes has been made and is outlined in leaflet No. 5 of 1913. No one up to the present has availed himself of the opportunities offered.

(4) Owing to the demand for vernacular training in agriculture the co-operation of the Revenue district officials of the Coimbatore district has been sought to form a monthly class for the sons of well-to-do ryots who will attend for one day each month when the handling of implements, the use of manures and the value of improved methods of agriculture will be taught practically in the field.

V.—AGRICULTURAL CHEMISTRY.

(W. H. HARRISON, M.Sc.)

The main line of investigation will continue to be in connection with paddy and paddy soils. It has been found possible during the present year to summarize the greater portion of the past work and the conclusions, which may be briefly summarized as follows, have been prepared for publication :—

(a) The normal course of the fermentation of green manure in swamp paddy soils is affected by the presence of the crop.

(b) The soil conditions are anærobic in character and consequently nitrification cannot take place so long as the fields are under water.

(c) There is a film of organized matter over the surface of the soil which evolves large quantities of oxygen which appears to be utilized for the æration of the paddy roots.

(d) Drainage permits ærated water to penetrate the soil thus enabling the roots to go deeper and produce increased cropping.

(e) The effect of drainage is however not in proportion to the rate. The rate which produces the maximum effect is a comparatively slow one due to quicker rates decreasing the activity of the surface film and the æration of the roots.

(f) Green-manuring increases the activity of this film and consequently one of its functions is to increase the æration of the roots.

In continuation of the above future investigations will follow, as far as opportunity permits, the following lines :—

(a) A study of the carbon cycle in paddy soils.

(b) Drainage experiments with different soils.

(c) The source of the gaseous nitrogen present in the soil gases and its relation to the crop and manure.

(d) The nitrogen cycle in paddy soils.

2. Subsidiary lines of investigation will be as follows :—

(a) The completion of the soil survey of the Tanjore delta.

(b) A survey of the irrigated portion of the Guntur district.

(c) The composition of South Indian food-stuffs and fodders.

(d) The effect of the period of lactation on the composition of the milk of South Indian cattle.

VI.—MYCOLOGY.

(F. J. F. SHAW, B.Sc., A.R.C.S.)

Field Work.

Main Lines—Work in progress.—(1) Assistance will be given in the operations against the bud-rot disease of palmyras in the Gōdāvari and Kistna districts. The disease is still severe.

(2) Spraying with Bordeaux mixture against the *Mahali* disease of areca nuts will be continued. The operations last year were completely successful and resulted in more requests for assistance this year. There is a prospect that some ryots as a result of these two years' work will purchase spraying machines for their own use.

(3) Assist in the operations against a cocoanut disease in Malabar which has just been identified with the palmyra bud-rot of the Gōdāvari.

Research.

Main Lines—Work in progress.—(1) Investigation into the smuts of *cholum*, *cumbu*, paddy and sugarcane will constitute the main line of research. It is proposed to give some attention to the disease of paddy known as "Elephant Tusk" and also to the "bleeding" disease of cocoanut palms. The mycological nature of these diseases is at present doubtful.

(2) The collection and identification of the parasitic fungi of Madras will be continued.

Teaching.

The course in mycology for the students of the college which has recently been extended. The training of the staff will be continued.

VII.—ENTOMOLOGY.

Field Work.

Main Lines.—Assist in controlling the attack of the Deccan grasshopper if it continues. Remedial measures were demonstrated last year.

Research.

Main Lines.—Investigation of insect pests of Madras with special reference to details of life history and of means of control applicable on a field scale. This includes investigation of life histories of natural enemies, etc.

(a) *Aim.*—*Lessening of damage done by such pests.*

(b) *Results already obtained.*—It is impossible to summarize these here. Some information on about 300 pests has been accumulated, but the whole of this requires revision and extension.

(c) *Work during coming year.*—On lines indicated above.

Subsidiary.—Correspondence and active assistance by staff in case of outbreaks of pests and such other subjects for which opportunity may be found from time to time.

VIII.—(a) ECONOMIC BOTANY.

(F. R. PARNELL, B.A.)

The recent appointment of a Lecturing Botanist in sole charge of the Teaching and Systematic sections permits of the whole time being given to economic work. In the absence of any line of work already in hand an entirely fresh start will be made.

2. Extensive touring over the whole of the Presidency will be undertaken in order to become familiar with the most important crops and the agricultural conditions involved in their cultivation.

3. Preliminary enquiries point to the importance of paddy and cotton as crops on which work should be done. Special attention will be paid to these crops in order to decide whether it will be advisable to work on both as main issues or to make either subsidiary to the other.

4. At the same time the definite line of work and method of approaching the subject will be worked out and commenced.

(b) LECTURING BOTANIST.

(K. RANGACHARIAR, M.A.L.T.).

Main Lines—Work in progress—(1) *Teaching.*—A general course in Elementary Botany and an advanced course in Agricultural Botany.

(2) Collection of specimens for the herbarium in the districts of Tinnevelly, Salem, Ganjam, Vizagapatam and Gōdāvari and despatch to Mr. Gamble for his work on the Madras Flora when required.

(3) *Subsidiary Lines—Work commenced.*—A study of the weeds on the Government farms in the Presidency.

[This study was commenced with the Central Farm and Samalkota and plants growing during the hot weather have been collected and identified. The aim of the study is—

(*a*) to determine the kinds of plants growing in cultivated land.

(*b*) to see if there is any definite relationship existing between the crops grown and the weeds growing on the same land.

(*c*) to note the habit and the causes leading to the wide distribution and persistence of the more troublesome weeds.

(*d*) to ascertain with the aid of the Agricultural officers the cheapest and most efficacious ways of controlling them.]

IX.—SUGARCANE STATION, COIMBATORE.

(C. A. BARBER, Sc.D.)

At the last meeting of the Board of Agriculture, 1911, it was considered doubtful whether cane seedlings could be successfully raised in India, previous trials having generally resulted in total failure.

The question was taken up at Coimbatore by the Government Botanist during the Christmas holidays immediately succeeding the Board's meeting, but it was found that most of the canes had ceased to flower. Some, however, put out a few arrows and these were sown in pots on the chance of their providing seedlings. The sowing was done in various different ways, most of which have since proved to be unsuitable. Many of what were considered "successes" turned out to be grass seedlings, but a few which turned out to be true canes were obtained from four of our local varieties. The matter was finally set at rest by some arrows of Cheni received from Dr. Coleman in April, these giving quite a number of seedlings, and it was discovered that the opening of the anthers was the factor which determined the formation of seed. The cane arrows in North India only produce ill-formed closed anthers with no fertile pollen while many in South India are found to have well formed anthers which split readily and contain varying quantities of healthy pollen. A summary of the work at this stage was published in the Agricultural Journal of India.

The seedlings obtained were grown with great care in the Coimbatore Botanic Garden; at the same time a collection of Indian canes was started and these also were planted in the Botanic Garden, although in less suitable land.

The appointment of Sugarcane Expert was made on October 25th, 1912, and more rapid progress was made. A close study of the morphological characters of the different canes collected was commenced and special attention was paid to the anthesis of the local canes which were beginning to arrow. An effort was made to obtain as many seedlings from as many different parents as possible. Although it was a poor arrowing season, working with the experience gained in the previous year, we succeeded in getting a very large number of seedlings (12,000—15,000). Of these a few were obtained from arrows of canes growing in the Botanic Garden, but the great bulk were derived from South Indian canes grown in the fields round Coimbatore. In these circumstances little control could be exercised over the exact parentage. About 70 seedlings were obtained from selting arrows of *Saretha* and a number of crosses between *Saccharum spontaneum* and *Chin* and *Shakarchynia*, but in the greater number of seedlings the mother alone is certainly known.

Pending the acquisition of the land for a cane-breeding station, two long tours were made in North India, where the agricultural conditions were studied and many varieties of cane were collected and forwarded to Coimbatore. A detailed study of the morphological characters of these was made where possible with the object of determining their relationship to one another and their value as parents of possible seedlings. It was considered that the *Desi* canes of India would be more likely to produce healthy and hardy offspring than the better class canes which had from time to time been introduced into the country. Special attention has therefore thus far been directed to the indigenous canes. A further "rains" tour is in progress as this note is being written and, by the time the Board meets at Coimbatore, it is hoped that all sugarcane tracts of India will have been visited excepting Burma and Assam.

The farm land was acquired on the last day of the official year, March 30, 1913. A selection of the strongest of the seedlings was made and over 2,000 were planted out and are growing well at the time of writing. The varieties were also planted out, but in a less favourable position. Owing to the delay in the installation of the engine and pump, many of these varieties suffered severely because it was necessary to irrigate them with very alkaline water. The farm land is of the "dry" and "garden" type, it being considered more in keeping with the North Indian cultivation to grow the canes on this land than on the "wet" land usually employed. As however the farm land has never grown sugarcane before, it will take some time before, it is brought into proper condition for growing cane crops. The land for next year's plots is therefore receiving special attention.

The laboratory and farm buildings have been completed and the oil-engine and pump are working satisfactorily. A good road has been made connecting the Cane-breeding Station with the Central Farm so as to render it easily accessible.

Last year's seedlings have been reaped, analysed, exhaustively studied and replanted. Nothing very definite can be said as to the quality of the seedlings because the ground on which they were grown in the Botanic Garden was unsuitable, but in one at least the two main qualities desired, vigour and richness of juice, are united. The study and analysis of the large number of seedlings now growing will be difficult and the chemical part will be quite beyond the process of the single chemical assistant. It is hoped that some arrangement may be made by which chemical assistants can be borrowed from other sections for the two months or so during which the crop will be reaped. For various reasons it is considered desirable, at any rate at present, to analyse all the selected seedlings.

X.—VETERINARY.

(a) *Veterinary College.*

(D. A. D. Aitchison, M.R.C.V.S., M.P.S.)

As the work of the Madras Veterinary College is at present entirely tutorial only, it is not anticipated that any fresh ground will be broken during the year 1914-15.

(b) *Superintendent, Civil Veterinary Department.*

(F. Ware, M.R.C.V.S.).

1. (*a*) There is only one officer in the executive branch of the Civil Veterinary Department in this Presidency and his time is entirely taken up with routine office and inspection work.

(*b*) The work of the Department may be summed up under the following three heads :—

(i) the cure and prevention of disease ;

(ii) to give help and advice in the breeding and rearing of village stock ;

(iii) to induce the inhabitants of this country to apply to this Department for more help than they have done in the past, and resort to scientific methods of treating their stock, *e.g.*, to practise castration instead of "mulling."

2. For Nos. (i) and (iii) no programme can be made out. The diseases receiving the most attention will be those which happen to be the most prevalent during the year. As regards No. (ii) a definite programme for the future conduct of pony-breeding operations in this Presidency has recently been sanctioned by Government by which each stallion will be under the immediate charge of a special Veterinary Assistant.

This programme will probably be continued during 1914-15. The present system of supplying villages with stud bulls having proved unsatisfactory, the procedure to be followed in the future needs consideration, but it has been decided to leave this in abeyance until the review of Government on the report of the officer deputed to carry out a cattle survey has been received.

7.—CENTRAL PROVINCES AND BERAR.

I.—AGRICULTURE, NORTHERN CIRCLE.

(G. Evans, M.A.)

Experimental Stations.—The Powarkheda Farm will continue work on the same lines. Wheat-selection and hybridization are now being done in co-operation with the Economic Botanist, and the work will be gradually handed over to him entirely. The area of the cattle-breeding farm has been extended slightly, and the herd is now more uniform, and a keen demand has arisen for the bulls.

The Adhartal Farm, Jubbulpore, is mainly concerned with rice and garden crops but a certain area has been set aside for experiments in the cultivation of embanked wheat lands. Irrigation experiments will be carried out in order to find out the amount of water necessary for each of the important crops. There are seed and implement depôts attached to each of these farms, and the demand is now very considerable and is rapidly assuming large proportions.

Demonstration Farms.—Small demonstration farms are now being arranged at various centres. These farms vary in size from 6 to 20 acres. The land is either acquired or more usually leased for a short term of years. They are worked by a Kamdar who is a local man trained on one of the Experimental Farms. New varieties of crops, a particular method of cultivation, or one or two improved implements are demonstrated, varying according to the tract in which the farm is situated.

One dozen are at present in existence, and these numbers are gradually being extended as trained Kamdars become available.

These small demonstration farms promise to be a great success, and groups of neighbouring cultivators at once take a critical interest in the farm and begin to copy the methods carried out on it. The Kamdar is usually literate and is allowed to register orders for seeds and implements.

Seed Farms.—Seed farms for the propagation of new and selected varieties of wheat, gram, til and cotton have been organised. At present some 70 are supervised by the Department and their numbers are yearly increasing. These seed farms are privately owned and generally belonging to the Malguzars. Seed is obtained from the Government Farms in the first place, and the site of the seed farm is selected by an officer of the Agricultural Department in consultation with the owner. Simple rules regarding the cultivation, threshing and storing of the crop have been laid down to ensure the continued purity of the produce, and the Malguzar agrees to carry them out. The seed farms are inspected during the growing period and on the threshing floor by the Agricultural Assistant in charge of the circle, and a certificate is given if the rules are properly carried out and the produce is up to standard. The demand is so great that the Malguzar generally has no difficulty in disposing of the produce for seed purposes locally, but if necessary the Agricultural Department assists him in finding a market.

Agricultural Shows.—District Agricultural Shows are held once a year in each district annually at the time of some big religious fair. Departmental exhibits of improved kinds of seeds are sent and demonstrations of machines and implements carried out. The judging of the local exhibits is done by an officer of the Department, and special prizes are given for those crops to which attention is mainly directed in that district.

Agricultural Associations.—The District Agricultural Associations are being rapidly split up into Tahsil and even smaller committees. These naturally spring up in the areas in which demonstration plots have been opened. These small committees have proved singularly successful in most cases.

Co-operation.—Agricultural unions consisting of village co-operative societies have been started in the Sehora Tahsil. Members of the union can obtain loans for the purchase of seeds and implements, approved of by the Agricultural Department, from the Central Bank, and agree to carry out certain simple rules which ensure that the seed so obtained is properly grown and kept pure.

The seed supply association is now located in the building of the Central Bank, and orders for seeds and implements can be registered there by any member of a co-operative society. Samples of the various seeds and implements recommended are on view in this office, and a demonstration farm owned by one of the directors is situated close to the Bank in which these seeds are actually grown and in which the new implements can be seen in regular work.

An agricultural union, organized on slightly different lines to the above, has also been started at Betul and here, as at one or two other places where the co-operative movement has taken firm hold, a promising agency exists for the rapid introduction of improved agricultural methods.

Further developments are being greatly hampered, however, by lack of staff, more especially in the superior grades of the service.

II.—AGRICULTURE, SOUTHERN CIRCLE.

(D. Clouston, M.A., B.SC.)

[*The most important points are marked.**]

Berar Division.—*It has been definitely proved on the Akola Farm that at present Rosea is easily the most profitable cotton for the cotton tract of these Provinces. Of the non-experimental area of about 230 acres about 200 will be devoted to the propagation of selected strains of this type of jari. All the seed will be supplied to the seed farms of the tract. Of these there were 120 last year which yielded nearly one million pounds of Rosea seed. To enable the Department to propagate and distribute larger quantities of Rosea seed, 25 Agricultural unions have been formed : the number of these unions will be increased, when their efficiency has been tested.

Hybridizing will be continued : three crosses of some promise are being tested to ascertain their value per acre as compared with that of Rosea. The selection of Rosea with the view of increasing its percentage of lint to seed will be continued. A strain giving 40 per cent. lint is being propagated. Buri which has proved to be resistant to wilt will continue to be recommended to cultivators who have wilt-infested areas.

2. The plant-to-plant selection of the most productive juars under trial will go on as usual, and seed of the heaviest yielding varieties will be distributed.

3. *By the experiments carried out on the farm for the last seven years it has been conclusively proved (i) that Rosea is much more profitable than ordinary mixed Berar jari ; (ii) that close spacing of about 7″ in the rows gives the largest outturn on soil of medium fertility ; (iii) that topping cotton plants reduces the yield ; (iv) that the manurial value of cattle urine conserved by the dry-earth system is equal to that of their dung for the same period, and (v) that poudrette is the cheapest of the locally available manures.

4. Cotton growers will be advised to incorporate these findings into their general farm practice. The results of any practical value obtained from other experiments will be brought to the notice of cultivators in due course.

5. The Department will from its Central Depôt at Akola supply oil engines, cotton gins, ploughs, hoes, fodder-cutters and other agricultural appliances, recommended for the use of Berar cultivators. Engine drivers will be trained on the Akola Farm to run the Gardiner oil engine, and the two trained engine-men employed by the Department will see that the engines supplied to land-owners are properly set up and repaired when out of order. Ploughs and hoes will also be stocked at the depôts maintained by private agents appointed by the Department. The number of agents will be increased, so as to have one in each taluq.

6. A cattle-breeding farm will be opened near Borgaon in Akola District with a view to improve the Khamgaon breed—one of the two distinct breeds of Berar cattle.

7. * *Nagpur Division.*—The Sindewahi Farm opened last year is being laid out mainly as a cane station. The experiments include the following :—

(i) the testing of exotic and indigenous varieties of cane and their time of ripening ;

(ii) the testing of different methods of planting ;

(iii) the testing of sheep and cattle manure, cakes and nitrogenous fertilizers ;

(iv) irrigation experiments with cane and cotton ;

(v) rotation experiments with cane as the principal crop ;

(vi) experiments to ascertain the best seed rate for cane ;

(vii) experiments to ascertain the best time to plant thick canes ;

(viii) selection of canes based on the density of the sets planted.

The soil on which these experiments are being carried out is a reddish brown sandy loam locally known as wardi. A duplicate series of experiments will be carried out on the Tharsa Farm on black soil.

8. The other crops under trial in these farms are fodder crops, rice, cotton, groundnut and wheat. Seed of these will be distributed to cultivators.

9. *The relative merits of Combodia, Buri, Rosea and Bourbon cotton grown under irrigation will be tested on the Sindewahi Farm. The first three of these have each given yields of about 1,000 lbs. *kapas* per acre this year. It has, therefore, been considered advisable to grow a considerable area of each so as to have seed for distribution next year.

10. Cane analyses will be carried out by the Agricultural Chemist and new varieties of rice will be supplied from time to time by the Economic Botanist.

11. *Telinkheri Seed Farm.*—The distribution of Rosea cotton seed through the agency of seed farms as in Berar will continue to receive careful attention. The testing of different varieties and strains and the production of crosses between Rosea and Bani will be continued. Seed for distribution will be raised on the Telinkheri Seed Farm.

12. A collection of over 40 varieties of cane is being tested. These will be analysed by the Agricultural Chemist. The most promising varieties as regards yield, quality, tillering and rattooning power and freedom from insect and fungoid diseases will be tried in the varietal series of the Tharsa and Sindewahi Stations.

13. The testing of fodders grown under irrigation will be one of the most important problems to be worked out. The experiments with irrigated pasture will be continued.

14. *Telinkheri Cattle-breeding Farm.*—The general management will be on the old lines. Two or three private farms on the lines of the Telinkheri Farm will be started. An experiment now in progress to ascertain the relative values of different cakes, cotton seed, mahwa and wheat, rice and cotton seed husk will be continued.

Sheep breeding has been started as an adjunct to this farm. The study of the diseases in collaboration with the Superintendent, Civil Veterinary Department, has been taken up and will be continued. Crossing will be taken in hand as soon as merino rams are obtained.

14-*a*. *Telinkheri Dairy Farm.*—This is in effect to ensure a satisfactory whole milk supply. It is a co-operative society of Gaolies opened in the present farm in 1912. Cows and buffaloes are maintained on the farm by Gaolies from Nagpur: the Department provides the food-stuffs, controls the milking and hands over the milk to a contractor.

Experiments in crossing with the object of producing an improved milch breed are being carried out between a Montgomery bull and selected cows of the Gaolao and Hansi breeds belonging to the Department, and between the Delhi and the local buffalo.

15. * The demonstration work already in hand in this Division will be still further developed. It includes the introduction of suitable thick canes and groundnut in Chanda District, and of thick and thin varieties under Government tanks in Bhandara and Ramtek. The Department has, as a result of its demonstration work, created a demand for oil cakes for manurial purposes. The manurial value of this cake will continue to be demonstrated under Government tanks.

16. The Poona system of gur-making will be demonstrated wherever cane is grown on a considerable scale, and the sale of certain agricultural machinery including iron cane mills will be pushed.

In Bhandara and Chanda Districts cultivators are being instructed in the single seedling method of transplanting rice.

17. *Chhattisgarh Division.*—The experimental programme of the Raipur Farm includes (i) methods of cultivating and manuring rice; (ii) the testing of varieties of rice, groundnut and wheat; (iii) the testing of different seed and water rates and spacing distances for transplanted rice. The Farm will continue the work of plant-to-plant selection and to supply cultivators with paddy, groundnut, wheat and sugarcane for sowing purposes. An experimental farm will be opened in Kawardha, one of the Feudatory States, for the investigation of agricultural problems relating more especially to cotton.

18. * The transplantation of rice is the most imporant piece of demonstration work in hand: an area of about 16,000 acres was transplanted under the supervision of the Department last year. The success attained is largely due to the fact that in carrying out its demonstration work in the Division the Department has employed as instructors in the villages a large number of trained Kamdars. The number of Kamdars will be increased if suitable men for these posts can be obtained.

19. The introduction of cane and groundnut will also receive attention. As a result of the work done in demonstrating the value of cake as a manure for sugarcane about 100 tons of cake is being applied this year as a cane manure in this Division alone.

20. The Department has opened a cattle-breeding farm at Chankuri. The site selected is commanded by irrigation. The possibilities of raising fodder crops throughout the year and of producing good pasture by irrigation will be investigated. The Department will supervise the breeding farms opened by private individuals: the number of these is increasing.

21. *Agricultural Associations.*—Meetings will be held as usual twice a year. The annual Divisional meetings which have been held on the Raipur and Akola Farms for the last four years will be continued. The members of these associations take a leading part in their districts in introducing improvements, and as an incentive medals and sanads are granted to selected men. To expedite business at the Divisional meeting of the Berar Association last year, committees were appointed to consider and report on (i) the exhibits of cotton, juar and groundnut sent in, (ii) the distribution of cotton seed through Agricultural unions working on co-operative lines and (iii) arrangements to be made for the sale and repair of agricultural implements. When the terms of reference are clearly defined and the committee meetings held on the day previous to the general meeting, much useful work can be done in this way. This system will be followed in future.

22. The Agricultural Gazette is in a flourishing state. There are now over 6,000 subscribers. A section on co-operative work edited by the Registrar of Co-operative Credit Societies has been added. This Gazette serves a very useful purpose: its popularity is extending. Leaflets will be issued when necessary.

23. The practical course for the training of private landholders in rice and cane cultivation and managers from Court of Wards will go on as usual on the Raipur Farm.

24. Orphan boys will continue to be taken on the Raipur and Telinkheri Farms for a three years' course of training. There are at present ten under training on the latter farm.

Sections 1, 3, 7, 9, 15 and 18—Are the most important works in the Southern Circle.

III.—AGRICULTURAL COLLEGE AND CENTRAL RESEARCH STATION.

(R. G. Allan, M.A.)

[The most important points are marked.*]

1. A large portion of the Principal's time is absorbed by the College, delivery of lectures, control of practical classes and College routine.

2. The following investigations have been in progress during the past two years, and the majority will be continued.

3. * An examination has been made of the questions of double cropping and green manuring before wheat, grown dry, under the local conditions of rainfall, *i.e.*, some 40″—45″ received chiefly between 20th June and 20th September. The investigation has been chiefly directed towards the effect of the length of time elapsing between harvest of the first crop or inversion, in the case of a green crop and the sowing of the wheat and the amounts of rain received during this period. Lateness in sowing the green crop and its effects have been noted. The plots treated as above have been checked by different types of fallow cultivation during the rain. The effect of phosphates in conjunction with green manuring has also been under examination. A series in conjunction with irrigable wheat land is under consideration, as certain indications of the present series lead one to believe that certain factors, other than the possibility of applying water to the wheat crop, have to be considered.

The general indications of this work which has now been in progress four years are—

(*a*) that for success a precipitation of at least 10″ is required between inversion and wheat sowing;

(*b*) that more certain success is to be found if 16″ is available;

(*c*) that to effect this, early inversion by the end of July is essential, as success is more closely associated with earliness than with the size of the green crop turned out;

(*d*) that the presence of a small quantity of phosphoric acid (i) hastens the rate of growth of the green crop and (ii) induces a bigger return in the succeeding wheat;

(*e*) that *Sann*, the green crop which is most efficient, should be sown early in June, and that if the monsoon is unduly delayed to prevent this, it is advisable not to attempt green manuring.

4. * Wider spacing and inter-tillage of wheat and lower seed rates have been under examination, the general indications being that a lower seed rate, a wider space between the lines of plants and one intercultivation increase the yield.

5. Preparatory tillage before cotton, juar and wheat have been under examination. The general conclusions are that, with regard to kharif crops, deep cultivation must be entered upon after consideration as to the direct effect of the added water held by the surface soil during July and August. The growth of both crops is closely associated with unchecked advance when young. In areas where drainage tends to be imperfect under local conditions of rainfall, any benefits derived by the crop as a result of an increased water storage are largely neutralized by the harmful effect of this water when the plant is young. Deep cultivation under such conditions, specially when it is realized that the local jari is a rapid maturing type and is thus less dependent on store and water, produces no marked advantage in returns, though costing more. In the case of rabi crops opening up the land invariably adds to the yield. Hot weather cultivation, however, does not show any appreciable advantage over land broken up after the first fall of the monsoon. In the black soils hot weather cultivation is laborious and costly, though the cost can be considerably reduced if the previous crop was a kharif one and if after harvest the land is promptly worked with a disc harrow or bakhar.

6. * Linseed-breeding has been in progress now for five years. Early types and distinctly heavier yield types of both the white and red seeded varieties have been isolated and are being reproduced.

7. * The juar crop has received close attention as a grain and fodder producer. The majority of the Central Provinces juars have been grown and tested. The numbers have gradually been reduced till the most promising varieties only are left. These are being improved by steady selection and line growths.

8. * Soybean has been under examination for the last 2-3 years. A number of types has been introduced and tested, and the better selected. Those, which are most prolific on this black soil, either suffer from being very late or having a low oil percentage, or both. To be successfully introduced as a field crop, Soybean must be either distinctly early so as to be grown as a catch crop before wheat, which from the work in Section 2 appears quite feasible, or if as a late crop or whole season crop the outturn of the type introduced must be heavy and its oil percentage good. Work is being conducted along these lines; but the general indications are not particularly hopeful as to the suitability of this crop for black cotton soils.

9. Tillage to prevent erosion, different types of water breaks and water drainage are at present under experiment.

10. * With the opening of a small sewage disposal plant on the College Farm, investigation into the most suitable crops and methods of tillage and soil treatment has been begun. The chief dangers lie in the harmful effects of excessive application of water to soil of black cotton type and the possibilities of sewage richness. The field area has been divided into four sections:—

(1) underdrained, (2) cultivation in flat beds with annual crops, (3) cultivation in various forms of ridge and furrow and frequent inversion growing annual crops and (4) a section growing perennial or semi-perennial crops partly on the flat and partly in ridge and furrow with frequent inter-cultivation.

The sewage will be applied in different quantities and different states on each section, and the crops grown will be chiefly those of heavy growing character.

11.* A dairy farm fully fitted and equipped has been attached to the College. It will chiefly deal with milk products and high quality milk only. Regular observations have been begun with regard to individual milk-yield and fat-percentage. One feeding test with buffalo calves has been completed.

The following lines of enquiry of an experimental character are under consideration:—

(i) The effects of different concentrates on the hardness and softness of butter in the hot weather.

(ii) The factors affecting the quality and texture and flavour of *ghee* and effect of heating.

(iii) The preparation of a cheap and wholesome substitute containing *ghee* in place of pure *ghee*, as the latter is only paying at about Rs. 1-10-0 to Rs. 1-12-0 per seer.

(iv) The feeding of buffalo stock.

The marked differences in the quality of milk from individual buffaloes indicate the possibility of improvement in any required direction by breeding.

12. A study of the germination of farm seeds under different conditions of storage has been commenced. This and No. 6 are chiefly under the control of my First Assistant.

13. A study of the best method of storing and making farmyard manure is under consideration, but progress has been too short to allow of any statements.

14.* Feeding experiments with work stock have been conducted and will be continued.

The above are the chief lines of work undertaken and in progress at the present time. I do not intend to add materially to this list in the next two years as their continuation will fully occupy my time and that of the limited staff at my disposal. The sections marked* may be considered as the main lines of investigation in progress and in the future.

IV.—ECONOMIC BOTANY.

(R. J. D. Graham, M.A., B.Sc.)

The principal work to be undertaken by the Economic Botanist and his staff will be the improvement of rice, cotton, juar (*Andropogon sorghum*), wheat, the genus *Capsicum* and bajra (*Pennisetum typhoideum*. Minor investigations will be carried out on *Sesamum indicum*, *Cicer arietinum*, the genus *Phaseolus* and the genera of the *Cucurbitaceæ*.

Rice—Oryza sativa.—The classification of the Central Provinces rices has been completed. The best varieties of local rice have now been ascertained, and an attempt will be made to improve these, the aim being to evolve a rice in which yield and quality are combined.

Cotton—Gossypium neglectum.—A demand has arisen for an early cotton suitable for the cotton-growing tracts of the plateau.

Andropogon sorghum.—The varieties of juar grown in the Central Provinces have been studied. Recently work has been confined to the study of natural cross pollination which has been found to occur frequently in this genus. A paper on this subject is being prepared.

Wheat—Triticum sativum.—Work is being done in co-operation with the Deputy Director of Agriculture, Northern Circle, and consists in the testing of foreign wheats and the evolution by crossing or selection of pedigree wheats suitable for the various tracts in the north of the Central Provinces.

Capsicum.—The varieties grown in the Central Provinces have been worked out by the Assistant Economic Botanist, and the work will be published shortly. Selection of suitable strains will be continued.

Bajra—Pennisetum typhoideum.—The varieties grown in the Central Provinces are still being studied. The problem is complicated by the occurrence of natural cross pollination. Two useful types have been selected

Sesamum indicum.—Til has been grown under observation for two years by an Assistant. The varieties grown in the Central Provinces are being determined, and selection in co-operation with the Agricultural Chemist will be carried out.

Cicer arietinum and Phaseolus.—It is proposed to make a detailed survey of the varieties grown in the Central Provinces. Some varieties have already been collected.

The work in the Herbarium will be continued as formerly. A list of the *Eriocaulaceæ, Cyperaceæ* and *Gramineæ* found at Nagpur, with those commonly met with on other farms, is in the press.

The collection of plants in the Botanical Garden will be continued as laid down.

The successful carrying out of these lines of work depends on the completion of suitable work-rooms. Up to the present work has either been seriously handicapped or curtailed as no laboratory is available.

V.—AGRICULTURAL CHEMISTRY.

(F. J. Plymen, A.C.G.I.)

Work in the year under consideration will be in continuation of that described in the programme for 1913-14, furnished to the Board of Scientific Advice for India at its meeting held in May 1913.

(1) Educational work will be continued on the present lines unless any modifications should be necessary as a result of the consideration to be given to this subject by the Board of Agriculture at its next meeting.

(2) Agricultural analysis as required by the Department and outside public will be carried on. The amount of work of this nature coming to hand is increasing and severely taxes the resources of the present temporary laboratory.

(3) The amount of research work which will be undertaken depends entirely upon the completion of the necessary laboratories. It is proposed to commence the following main lines of work so far as opportunity permits :—

(*a*) The changes which take place when town sewage is applied to black cotton soil. This will be carried out in conjuction with the Imperial Agricultural Bacteriologist, at present on land under the control of the Principal, Agricultural College, Nagpur. The object in view is to determine to what extent sewage can be applied to a fairly heavy soil as a means of sewage disposal and what will be the effect of continuous application upon the soil complex. The degree to which, if at all, the sewage should be partially purified before application will also be determined.

(*b*) A study of the variation in the chemical and physical characteristics of butter-fat produced by changes in season and feeding. The object of this investigation is to determine how far the various criteria which denote the purity of a butter-fat vary under perfectly normal and natural conditions. It will be conducted on separate herds of cows and buffaloes, the size of the herds being as large as possible to eliminate the individual characteristics of any animal.

(*c*) The following subsidiary line of work will be undertaken, the necessary samples being supplied by the Economic Botanist :—

A study of the composition of some of the chief local varieties of rice from a consideration of their popularity amongst rice-eaters, with a view to determining why certain varieties are held in such high repute. The distribution of the nitrogen in the grain will be investigated.

(*d*) In continuation of work carried on in former years, the selection of sugarcane suitable for local soils and conditions will receive attention in collaboration with the Deputy Director of Agriculture, Southern Circle. A number of varieties is under observation, but up to the present only a few have been grown on a large scale. Some varieties, *e.g.*, *Pounda* and *Lanji*, contain a good percentage of sucrose and have high coefficients of purity, but take apparently a full year in which to ripen. In order to lengthen the harvesting season early ripening varieties are required.

VI.—VETERINARY.

(Major W. O. Dawson, A.V.D.)

I. (*a*) *Investigation of the serious outbreak of disease among cattle in Telinkheri Farm.*—Prevalence of Piroplasmosis among cattle in Nagpur including—

(*a*) Piroglasma Bigeminum.

(*b*) Anaplasma Marginale.

(*c*) Theileri Mutans or Parvum.

All these forms have been found in cattle, and we are endeavouring to discover as far as possible the pathogenic power of these parasites on cattle in the Province.

(*b*) Investigation of Fluke disease among cattle and sheep and the source of the disease.—These investigations are at present being carried out.

(*c*) Experiment with treble dose of Anti-Rinderpest Serum in a selected district or districts by a moveable column and comparison as to its effect with the single dose.

II. (*a*) During the past year a number of *post-mortem* specimens of tissue, blood, etc., from the sheep kept at the Telinkheri and Sindewahi Government Farms was received for microscopical examination. The sheep had been suffering from certain fatal diseases, the clinical appearances of which were very indifferent. The most frequent disease and apparently the most fatal was very acute : animals were not ill for more than a day or two and then died from what would appear to be an acute Septicæmia. From the above observations it would appear that the cause of death was a rod-shaped anthracoid organism, which differed slightly from Anthrax and malignant Oedema. Its presence was constant in the blood. It is proposed to continue these investigations for Piroplasmosis and Anaplasmosis in sheep in Nagpur.

(*b*) The preventive prowers of Anti-Rinderpest Serum have been found to be not quite so efficacious as they have always been considered, and a special report on the subject has already been forwarded to the Government of India. It is now proposed to increase the dose in selected areas and compare the results with areas in which the ordinary dose has been administered. This will, however, be undertaken only when the sanction of Government is received.

8—ASSAM.

I.—GENERAL.

(J. McSwiney, M.A., I.C.S., *Director of Agriculture.*)

The programme given below is that of the Deputy Director of Agriculture, the only officer of the Indian Agricultural Service attached solely to this province. The Chief Commissioner has applied for the appointment of a whole-time Agricultural Chemist: under the present arrangements we have a share of the services of the Agricultural Chemist, Fibre Expert and Economic Botanist, Bengal. Without a whole-time Chemist work in connection with sugarcane and soil research cannot be extensive as we would wish.

2. An experiment station for growing European fruit has been opened at Shillong under the supervision of Mr. C. H. Holder. About 3½ acres have been already laid out during the last cold weather: the main object of the experiment is to discover what European fruits are likely to succeed in the Khasi Hills.

3. Rai Bahadur Bhupal Chandra Basu, late Deputy Director of Agriculture, Eastern Bengal and Assam, has been placed on special duty to enquire into the present condition of the silk industry in Assam with a view to the introduction of improved method of rearing, weaving and disposal of the finished article. His report is expected in the spring of 1914 and action will be taken on its receipt.

II.—AGRICULTURE.

(A. G. Birt, B.Sc.)

Staff.—The superior staff at present consists of one Deputy Director. Proposals have been made for the appointment of an Agricultural Chemist and it is hoped that sanction will be obtained and the appointment made during the current year.

An Agricultural Supervisor and two District Agricultural officers were appointed on probation from June 1st, 1913.

There are three Farm Superintendents in charge respectively of the Shillong, Jorhat and Sylhet Experiment stations.

A graduate of the Poona Agricultural College is now under training at Pusa for the post of Entomological Assistant, and if found suitable will be appointed to this post on completion of his training in November next.

2. *Experiment stations, etc.*—In addition to the Experiment stations at Shillong and Jorhat, about 80 acres of land have recentlybeen acquired near Karimganj, Sylhet district, mainly for experiments with paddy and jute. The work of laying out the new station will be commenced in the cold weather of 1913.

A Chemical Laboratory has been sanctioned at Jorhat, and the building will, it is hoped, be commenced by 1914.

It is proposed to open a godown at Gauhati for the sale of special seed, manures and implements recommended by the Department.

3. *Experiments (major)*—

(*a*) *Sugarcane.*—At Jorhat work in the past has mainly been directed to testing indigenous and exotic varieties of cane under chemical control in collaboration with Mr. A. A. Meggitt, Agricultural Chemist, Bengal. Results up-to-date prove that several varieties of exotic canes will, in Upper Assam, yield at the rate of 30 tons of cane per acre with a juice containing from 16 to 18 per cent. of cane sugar and a purity co-efficient of over 90.

Work in progress includes the further testing of varieties, manurial experiments (mainly the relative values of cowdung and oilcake), and planting experiments.

As regards future work it is proposed to continue the testing of varieties, and to extend the manurial and planting experiments with a view to ascertain the most economical methods of cultivation.

With the object of attracting the attention of capitalists to the possibilities of sugarcane in Assam, it is proposed to open up and plant sugarcane on an area of about 1,000 acres in the district of Kamrup by means of steam-cultivating tackle. The steam-tackle experiment will probably not be commenced until the cold weather of 1914-15 but in the meantime in order to provide a supply of " sets " we propose to plant about 40 acres of good varieties of cane in the spring of 1914 on the site of the experiment.

(*b*) *Soil improvement investigations.*—The field experiments in connection with these are being carried out on the Jorhat Farm in collaboration with Mr. Meggitt.

The past four years' work has shown the enormous importance of lime as an ameliorating agent on these acid highland soils. The great value of cowpeas as a green manure crop on limed land has also been demonstrated.

Work in progress includes the continuation of the work commenced in former years chiefly with a view to ascertaining the optimum rate and frequency of application of lime. In addition to this an experiment on a large scale has recently been laid down to test the effect of ground limestone on this soil.

Future work will consist in carrying on the above experiments and amplifying them as the occasion arises.

(*c*) *Potatoes.*—This is the most valuable crop in the Khasi Hills. Experiments at the Shillong Farm in the past have proved :—

(I) that no variety remains long immune to disease (*phytophthora infestans*) in these hills of heavy rainfall ;

(II) that Bordeaux mixture is effective in checking disease, and that spraying with this fungicide is extremely profitable ;

(III) that when cowdung is scarce, oilcake may be used with advantage to supplement the supply, but that soluble artificials, with or without cowdung, are not profitable owing to their high price delivered at Shillong, and to their liability to be washed out by the heavy rains ;

(IV) that " seed " saved from the winter crop is very much more productive than " seed " saved from the summer crop.

Work in progress consists mainly of testing new varieties imported from England, and of growing large quantities of " seed " of the best varieties for sale to cultivators.

Subsidiary investigations include an experiment in manuring with insoluble phosphates mixed with cowdung, and testing whole sets against cut sets.

Future work will consist almost entirely of testing imported varieties and of growing large quantities of seed of good varieties.

4. *Experiments (minor)*—

(*a*) *Rice.*—At Upper Shillong, experiments have been commenced to test the value of transplanting against broadcasting ; also raw bonemeal and ground rock phosphates as manures.

When the new experiment station at Karimganj has been equipped, rice will come under the head of "Major experiments," but until then nothing can be done in the plains.

(b) *Fodder crops.*—Experiments are being made with indigenous and exotic fodder crops at the Upper Shillong Farm with a view to solving the question of the winter fodder supply in the hills. Up to the present no exotic crop has been successful, but several indigenous crops, *e.g.*, maize, soybeans and *raishan* (a local millet), have proved excellent for the purpose, the former for silage and the latter two for hay.

In this connection experiments with pit silos and hay-making will be continued.

After this year it is proposed to drop trials of exotic fodder crops, and concentrate on the indigenous ones.

(c) *Introduction of new crops.*—At Jorhat ground-nuts, potatoes and Manchurian soybeans are being grown experimentally with this object. Both ground-nuts and soybeans do exceedingly well, but potatoes have not been so successful. This will be continued.

(d) *Improvement of indigenous crops.*—At Upper Shillong a commencement will be made to improve the local maize, and several millets by selection.

(e) *Cattle breeding.*—The breeding of pure Patna bulls for sale to cultivators will be continued at Upper Shillong.

(f) *Sheep breeding.*—The experiment of crossing Khasi ewes with Dumba rams will be continued at Upper Shillong. As there is already sufficient evidence that the cross is a great improvement on the local breed, a few Dumba ewes have been imported for the purpose of an experiment in the breeding of pure Dumbas. If this proves successful, pure Dumba rams will be bred for distribution in the hills.

5. *Demonstration.*—The use of bonemeal and flour phosphate as manures for paddy will be demonstrated in four districts, *viz.*, Sibsagar, Sylhet, Kamrup and Khasi Hills. There will be 10 centres in each district.

In addition to the above there will be potato cultivation demonstrations in the Jowai subdivision of the Khasi Hills district, and during the potato-growing season twelve expert sprayers will be sent out to spray the potatoes of Khasi cultivators with Bordeaux mixture as a preventive of disease.

A bone-crushing plant will be installed shortly at Upper Shillong to crush the local supply of bones for sale as bonemeal to cultivators. In the absence of local enterprize this innovation is necessary owing to the fact that the heavy freight charges from Gauhati to Shillong are preventing the extension of the practice of using bonemeal as manure in the hills.

6. *Training of demonstrators.*—Four apprentices, sons of cultivators, are under training for the post of demonstrator, two at Shillong and two at Jorhat. There is also a Lushai youth under taining at Shillong.

Two men who have gone through their period of training at Jorhat are now employed as demonstrators in the Sibsagar district, and three men who have gone through a similar course of training at Shillong are employed as demonstrators in the Khasi Hills.

7. *Miscellaneous.*—The breeding and distribution of improved breeds for poultry will be continued in the Lushai Hills. Two Lushai Agricultural assistants have recently been appointed to work under the orders of the Superintendent, Lushai Hills, with a view to the general improvement of agriculture in this tract. The work is under the general supervision of the Agricultural Department.

In the Naga Hills the introduction of terraced rice cultivation, and trials of fruit trees will be continued by the Deputy Commissioner.

It is proposed that the Political Officers of the North-East Frontier Tracts (Abor, Miri and Mishmi countries) should take up the improvement of local agriculture in consultation with, and with the help of the Agricultural Department. The Deputy Director will, if possible, visit these tracts, consult the Political Officers and advise as to what can be done.

III.—VETERINARY.

(S. G. M. Hickey, M.R.C.V.S.)

1. *Constitution.*—The Department is at present managed by one Superintendent; there are three Veterinary Inspectors, each one being placed in charge of a certain number of Assistants whose work he regularly inspects. Besides the duties of inspection an Inspector also investigates outbreaks of contagious disease and superintends the inoculation work in the field. The total number of Veterinary Assistants now employed in the province is 37, of whom one is staff, five are reserve, three hill districts and twenty-eight plains districts Veterinary Assistants. The sanctioned cadre of Assistants is 51 and it is proposed to appoint as many Veterinary graduates as available in 1914-15 towards the completion of the cadre. Under orders of the Local Administration each Local Board is to employ two Assistants, one stationary and one itinerating or both itinerating as required for each of the subdivisions. Nine Boards out of 19 have now 2 Veterinary Assistants; during the year 1914-15 every attempt will be made to provide each Board with the full number of Assistants.

2. *Training and Recruitment.*—The Administration now sends students to the Bengal Veterinary College with stipends for training and the qualified graduates are taken in the Department as Veterinary Assistants. Stipendiaries are also being sent from this province to the Bengal Veterinary College by the Local Boards. To attract a good type of men the value and number of the Government stipends has been increased; new conditions of prospects and pay of service are being considered by which the cadre is to be improved in the future.

3. The following are the principal classes of contagious diseases with which the Department have to cope:—

Rinderpest, Anthrax, Foot-and-mouth disease, and Hæmorrhagic Septicæmia: cases under the Glanders and Farcy Act are not very uncommon in this province. The work of the Veterinary Assistants is at present mainly directed to treatment of contagious diseases of cattle and other domestic animals, especially by inoculation, enquiries into the causes of outbreaks and the results of inoculation, and instruction of villagers in the treatment and breeding of their stock. In outbreaks of Rinderpest the Assistants generally inoculate cattle and the results have been up-to-date satisfactory; inoculation against Anthrax is always undertaken when the disease is microscopically diagnosed and with satisfactory results.

In the following statement are shown the number of animals immunized with Serum treatment and the mortality amongst the inoculated animals:—

No. of outbreaks in which inoculation was undertaken.	Name of disease against which inoculation was carried on.	Number of animals which died uninoculated in course of outbreak.	Number of animals inoculated.	Number of animals which died after inoculation.
1	2	3	4	5
235	Rinderpest	8,408	27,361	842
20	Anthrax	162	1,933	89
12	Hæmorrhagic Septicæmia. . .	88	1,145	....
TOTAL 267	....	8,658	30,439	[illegible]

4. *Veterinary Hospitals and Dispensaries.*—The chief usefulness of the Department at present lies in the work done by itinerating Assistants in the mofussil and the energies of the Department are now mainly directed to increase the number of peripatetic Assistants; it is open to question if the whole-time services of a Veterinary Assistant can be always placed at the disposal of dispensaries. At present we have, however, only two Government Veterinary hospitals and one Local Board dispensary in the province; with a separate department for Assam it has become imperative to start a central large hospital at headquarters at Gauhati with a laboratory: the sanction to this project of the Local Administration has been obtained. The detailed plans of the buildings have been sent up and it is hoped considerable progress will be made during the year towards the completion. There are 19 Boards in the province; it is proposed to start two more dispensaries under the Local Boards during this year and efforts will be made to increase the number during the year 1914-15 and the next.

5. *Research work and Laboratory.*—In the year 1912-13, 156 specimens were examined, of which 13 were found to be Anthrax, 23 Hæmorrhagic Septicæmia, and 16 Surra. Several other blood and intestinal parasites were examined. In the absence of a fully equipped laboratory no research work could be undertaken on regular lines. With the construction of the laboratory which, it is hoped, will be complete during 1914-15, the Department will be in a position to frame a definite programme of work in connection with research.

6. *Breeding Operations.*—The improvement of the breed of cattle is a question which is at present awaiting the report of a special enquiry made in 1911-12, by Mr. J. R. Blackwood, now Director of Agriculture, Bengal.

9.—BURMA.

I.—Agriculture, Northern Circle.

*A. *Mandalay Agricultural Station.*—1. *Paddy.*—The work of selection and distribution of improved pure seed has been extended and will be continued. Our improved *Kalagyi* has been very favourably reported upon and efforts to still further improve this and other varieties by "line" breeding are in progress. The following experiments will be continued:—

(*a*) Manurial experiments with both local organic and chemical manures, including Nitrolim which gave promising results last year.

(*b*) Green manuring experiments.

(*c*) Rotation and cultivation experiments.

(*d*) Methods of sowing and planting—including a few spacing experiments.

(*e*) Water measuring experiments. To ascertain the best method of watering and the most economical quantity of water to apply. Also to find out the effect of stagnant water.

(*f*) Trials of exotic varieties, several of which show promise of success.

It is also proposed to commence experiments as follows:—

(*a*) On the best method of treatment and most economical seed rate in nurseries.

(*b*) The effect of liming.

(*c*) To ascertain the loss in manurial value, if any, due to the running off of irrigation water.

(*d*) To establish an identical series of manurial experiments at Hmawbi and Mandalay in order to correlate results for rain-fed and irrigated paddy.

Some of the difficulties of obtaining and maintaining pure seed were brought to my notice by one of the co-operative credit societies and afterwards by two individual Burmans in 1909. In order to elucidate the matter it was found necessary to ascertain—

(*a*) Whether self-fertilization or cross-fertilization is the rule among paddies.

(*b*) If cross-fertilization does take place, to what extent does it occur and whether there is need to take special precautions to prevent it during breeding and selection experiments.

(*c*) Whether crossed plants obey Mendel's law.

During the last two years five distinct and easily distinguishable types have been carefully "fixed." These are now being utilised for the above work which will be continued till reliable data have been obtained. The Assistant Botanist is helping in this line of work.

2. *Wheat.*—The work on this crop was last year greatly reduced owing to unsuitable conditions. It is not proposed to undertake any new expriments, but selection will be continued.

3. *Cotton.*—With the exception of Cambodia, the introduced varieties have proved to be of no value at Mandalay. Cambodia is still under cultivation and will be persevered with. Some seed has been distributed. The several tree cottons grown are valueless and will be uprooted.

4. *Pyaung.*—Selection and distribution of the improved varieties as previously.

5. *Taungya Experiments*—have been discontinued for the present.

6. *Poultry Breeding.*—Will be continued on a small scale as during the past years. Considerable improvement has been noticed in the poultry of surrounding villages as a result of distribution of stock birds and eggs.

7. *Implements.*—The scheme at present in vogue for the introduction and manufacture of new implements is proving most successful. We continue to manufacture a few—chiefly "*Gwinsets*" at the farm workshop. The demand is chiefly for *gwinsets*, small ploughs, cultivators, winnowers, chain-pumps, bullock threshing-machines and chaff cutters.

B. *Natywagon.*—1. *Peas and Beans.*—Classification and survey have been completed.

*(*a*) The main work on this area will consist of agricultural experiments to test imported Lima and other beans.

(*b*) As a subsidiary piece of work the breeding experiments at present instituted to obtain pure races of Burma beans free and phaseo-lunatin will be proceeded with.

This work is being carried out at Natywagon a short distance from the Mandalay farm on typical pea and bean soil.

2. *Groundnuts.*—Now that we have a small area suitable for their cultivation it is proposed to recommence the study and trial of varieties.

3. *Potatoes.*—Trial on small areas of a few European varieties with a view to improving the potatoes grown in the district.

C. *Ywathitgyi* (*Hopin*).—The trial of wheat in the Hopin valley will be undertaken if funds are available for the hire of a plot of land for the purpose.

D. *Myitkyina.*—The production and distribution of introduced varieties of potatoes. This work is being carried on in the old Government garden and shows every promise of success. The object is to encourage the cultivation of better varieties of potatoes than those which are now produced in the district.

E. *District Work.*—Consists chiefly of the introduction of new crop varieties in suitable places, extension of existing approved varieties and giving advice and assistance in agricultural matters to rural co-operative societies and others.

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*Main lines of investigation.

F. *Educational Work.*—This will be confined to practical instruction of the farm staff and district agriculturists, as no classes or courses are proposed for the coming year.

**Bugyi* (*Tantabin*).—A plot of about 3 acres has been acquired temporarily for the purpose of introducing paying dry crops such as Sessamum, Cotton, Pe-seingon, Pebyugyi, Groundnuts, and Jowar in the uplands and Wheat rotated with pulses such as Pe-gyi and Sadaw-pe on the lower lands or sanè. Deep and early cultivation will be tested for some, if not all, of these crops.

**Padu.*—This plot consists of from 22 to 24 acres of wheat and cotton soil and about 3½ acres of red upland "ya" cotton soil.

The objects in opening out this station are the improvement of wheat and cotton and if possible of the methods of cultivation and rotation. The chief aim will be seed selection—improvement and distribution of these two crops both of which, as grown at present, are of exceptionally poor quality.

**Pwinbyu* (*Striga lutea*).—The enquiry already undertaken with a view to the inception of remedial measures against this pest which is doing much damage to the Jowar crops in districts in the dry zone will be continued.

II.—Agriculture, Southern Circle.

(a) *The Hmawbi Agricultural Station.*—The station of about 400 acres is entirely devoted to problems in connection with the rice crop.

*1. The laying out operations mentioned in previous reports will be continued. At present 75 acres have been surveyed and bunded. During next year it is intended to take up about 30 acres more.

*2. A collection of paddy varieties from all the Lower Burma districts has been made and will be maintained as a permanent feature. From the varieties originally collected about 300 single-ear cultures have been made. A first classification of these according to grain shape has been made. This work will be continued during next year.

*3. A study of intra-varietal variation with a view to selection for uniformity of grain shape and colour and yield has been begun with six varieties specially suited to the requirements of the mills. One hundred single-ear cultures of each of these varieties are being experimented with. This work will form a permanent item in the programme of the station.

*4. In connection with the work of item 3 a study of cross-pollination in rice has been started. One year's observations have already been made and the work will be continued during season 1914-15.

*5. A scheme of manurial experiments for paddy has been drawn up. Work will be started during the present year and will form a permanent item in the programme.

*6. The question of the proper amount of seeding in the nursery and of distance and number of plants used in trans-planting will form the subject of an experiment.

*7. The experiment with improved implements mentioned in the last report will be continued. Owing to lack of buildings (which are to be erected during the coming year) it has hitherto been found difficult to carry on the work.

The above are all to be considered as items of work of the first importance.

(b) *The Môn Canal Station.*—This consists of about 10 acres only, is situated at Pwinbyu in the Minbu District and was acquired in 1912.

1. The introduction of improved varieties of paddy has been begun with six varieties and will be continued.

*2. The introduction of sugar-cane as a crop in the Môn Canal area will be attempted. It is intended to obtain improved canes from Madras for planting next year.

3. Cambodia cotton cultivation will be demonstrated.

Item 2 is to be considered of main, and items 1 and 3 of subsidiary importance.

(c) *Cotton Station.*—It is expected that a station for cotton and other dry crops will be opened during the year at Tatkôn in the Yamèthin District. Cotton will be the main crop and maize and sessamum subsidiary. Owing to absence of information no detailed scheme, however, has as yet been elaborated for this station.

(d) *Agricultural Surveys.*—It has been decided that owing to the demands of other work and to the fact that the surveys already done have furnished the necessary information for the work of the Experimental stations, these surveys be discontinued in the meantime. Accordingly the survey of the Kyauksè District mentioned in last year's report has been abandoned.

(e) Economic Surveys of crop varieties.

1. *Paddy.*—This work has been mentioned under Hmawbi.

2. *Sessamum.*—A collection from the districts was grown on a small plot at Tatkôn last year and a first series of observations made. This work will form part of the work of the station for cotton, if that be opened.

3. *Maize.*—In the event of the Tatkôn station being opened during the year a collection and examination of maize varieties will be made there.

**District work.*—1. *Distribution of Cambodia cotton seed.*—It is proposed to utilize co-operative societies as media for the propagation of improved or imported seed and the demonstration of implements. During the present year Cambodia cotton cultivation is being demonstrated on co-operators holding all along the railway line from Pyinmana to Mahlaing, also in the Pakôkku District west of the river. Last year a plot at Tatkôn yielded seed cotton at the rate of 1,250 lbs. per acre. Wheat and dâl (*Cajanus indicus*) are also being tried. Cultivation of the latter, mentioned in the last report, is making good headway in the dry zone.

2. *Distribution of paddy seed.*—Improved seed will be sent out from the Hmawbi station to a society where it will be multiplied by one of the members who will act as the seedman of his society, the seed being sold direct to the mills at enhanced prices.

*3. *District Agriculturists.*—Five District Agriculturists at present under training will be posted to five of the districts in the circle during 1914-15. Their duties will consist in helping societies with the seed work above mentioned and in collecting information regarding varieties, diseases, etc.

The supervision of these men and the conduct of the above mentioned district work is of the first importance.

III.—Agricultural Chemistry.

1. *Soils.*—* (*a*) A study of the relative fertility and manuring of some typical paddy soils.

This work consists of pot cultures which have been in progress for over two years.

(*b*) A survey of the Mandalay farm soil.

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* Main lines of investigation.

* 2. *Paddy.*—The effect of environment upon outturn, composition, quality, ripening and productivity of some paddy varieties.

The question of outturn and the study of varieties is only considered in a few particular cases.

Up to the present stress has been laid upon the chemical *differentiation of paddy varieties.*

On this subject two papers have been prepared and some more work is in progress.

With the aid of the new methods described in these papers it becomes possible to determine the effect of environment on rice quality.

This work has been commenced and forms now the most important inquiry in hand.

The work on paddy includes pot and plot cultures at Mandalay, plot cultures at six outstations and chemical analyses of soil crops and manures.

3. *Oil-seeds.*—The examination of some less common oil seeds.

The Programme of work of the Assistant Botanist and the Assistant Entomologist during 1914-15 will be in *continuation of that for 1913-14 as indicated below.*

IV.—Economic Botany.

1. Continuation of the study of Sessamums (in collaboration with the Deputy Director of Agriculture, Southern Circle, for varietal and other characters).

2. Pursuance of the investigation into the "Gwabo" of paddy.

*3. Study of the fertilization of paddy (in collaboration, with the Deputy Director of Agriculture, Northern Circle).

4. "Mendelian" or other inheritance of colour in *Pegya* (Phaseolus lunatus).

5. The Botanical aspect of the Phaseo lunatin question (in collaboration with the Deputy Director of Agriculture, Northern Circle).

V.—Entomology.

*1. The work of the past year in studying and advising on crop pests will be continued.

2. Experiments on white ants and other insect-pests.

3. Study of paddy and sugar-cane pests.

4. Study of mango-weevil at Maymyo.

5. Compilation of the necessary leaflets and bulletins.

VI.—Veterinary.

*As in past years the work of the Department will be concentrated on the prevention and treatment of outbreaks of cattle disease in the districts and the instruction of pupils at the Insein Veterinary School.

10—NORTH-WEST FRONTIER PROVINCE.

(W. ROBERTSON BROWN.)

(*a*) Aims.

(*b*) Results obtained since the *submission of the previous programme.*

(*c*) The directions in which it is proposed to continue the work during the coming year.

Crops.

Fruits (*a*).—The development of the fruit trade in the North-West Frontier Province.

(*b*) 60,000 young fruit trees of superior varieties of fruits have been distributed, to fruit growers during the past 2 years.

Imported peaches and plums have extended the marketing season of these fruits by nearly 2 months. Budded plants of good varieties of fruits are displacing seedling fruit trees.

Wood wool has proved to be suitable and economical packing material for ripe tender fruits, and it is being taken up by fruit dealers.

(*c*) In demonstrating on 50 acres of orchard land, that it pays to grow good quality fruit, and to market and pack scientifically.

In demonstrating how orchard insect pests can be economically controlled.

In improving facilities for the despatch and transport of fruits from the North-West Frontier Province.

Wheat (*a*).—To determine which wheats are suitable for the various tracts in the North-West Frontier Province and to maintain stocks of pure seeds of the selections. To encourage better cultivation in wheat growing.

(*b*) The more important wheat tracts have been examined and their wheats classified and grown at Tarnab and seed of the selected types is being sown on field areas this rabi.

Certain local wheats are of excellent quality and appear to be more suitable than Punjab or Pusa wheats for the North-West Frontier Province.

English Dreadnought wheat ripened 25 maunds of grain per acre at Tarnab. It was also very free from rust and its flour baked well. This variety may be useful in certain tracts or in breeding.

(*c*) In propagating and distributing the best types of local wheats. Ninety acres have been acquired for seed production and a large seed farm is to be established in 1913-14.

In testing foreign wheats under strict control.

In demonstrating improved methods of wheat growing on irrigated and unirrigated farms.

Maize (*a*).—The improvement of Peshawar White Flint maize.

(*b*) American varieties of maize have been extensively tried and have not proved more suitable to the Province than the local white variety.

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* Main lines of investigation.

(c) In the continued selection of Peshawar White Maize, and in the demonstration of improved methods of cultivation.

Cotton (a).—Improvement in the lint percentage of Peshawar cotton. The introduction of a high yielding long staple American cotton, and improvement in the cultivation of cotton.

(b) Selections of Peshawar cotton have been made, and are being propagated. American cotton, Multan Red Flowered cotton, Malvensis, and Rosea cottons have not yet shown that they are more profitable than Peshawar cotton.

(c) In the continuation of the trials mentioned above.

Barley (a).—The establishment of one type of high class barley in the Province.

(b) The examination of local barleys is being proceeded with, and the Murree Brewery Co. reported that two samples of English barley grown at Tarnab were the best they had seen, and were eminently suitable for malting.

(c) In propagating the best local barley and in carrying out extensive trials of the imported barleys under strict control.

a) *Sugarcane*.—Improvement in the quality of gur and the reduction of the cost of production.

(b) Mauritius canes were tried on field areas in 1911-12 and 1912-13 and they have not proved distinctly better than the local thick Peshawari sugar-cane.

A variety of Ukh cane from Partabgarh is finding favour in a district where the area under sugarcane was declining owing to the severity of the attacks of "red rot."

Early frosts, the limited supply of water and manure, and the unsuitability of the fields for the economical use of labour saving implements combine to make the manufacture of white sugar unprofitable in the North-West Frontier Province.

(c) In the continuation of demonstrations in methods of cultivation and gur making, and in further trials of the Mauritius and Partabgarh varieties of cane.

Tobacco (a).—The maintenance of stock of seed of a good type of *Nicotiana rustica*, and the encouragement of more intensive cultivation.

(b) Tarnab farm tobacco is the best in the neighbourhood, but this appears to be chiefly due to better cultivation. The cost of cultivation has been greatly reduced by the use of the Single wheel Planet Junior Hand Hoe.

(c) In the continuation of the work on the lines noted above.

Chillies (a).—The propagation and the maintenance of a good type of disease resistant chillies. Improvement in the cultivation of chillies.

(b) Farm chillies are fairly free from *Colletotrichum nigrum*, the disease which threatens to banish the crop from Peshawar District. But the comparative immunity is apparently due to the superior cultivation received. Imported American chillies were more seriously affected by "colletotrichum" than the local variety, and the disease appears to be equally prevalent in wet and dry seasons.

(c) In the continued selection of the best types of plants which are free from disease.

Sugar beet (a).—The provision of reliable data regarding the cultivation and the quality of sugar-beet in the North-West Frontier Province and the determination of the length of the season during which roots might be supplied to a sugar-beet refinery.

(b) The climate, the soil and the agriculturists' methods of work have been found suitable, and roots yielding as high as 20·03 sucrose in juice have been grown, while the average sugar content over ¾ of an acre was ascertained by Dr. Leather to be 15·56 at Tarnab.

(c) In the continuation of trials on the lines noted above and especially to ascertain the length of the beet root supply season.

Fodders (a).—The provision of green fodder and nutritious hay for work and dairy cattle, and for military horses. To obtain a grass to mix with clover, which can be cut by a mower, the rate of daily wages being very high.

(b) *Shaftal* in the North-West Frontier Province appears to be better all round fodder than Berseem for cattle, while Berseem is more suitable for horses and curing to hay.

Shaftal with rye grass is better than *shaftal* alone. Berseem and rye grass is excellent as clover hay.

Broad red clover and rye grass yield good crops of high quality hay in Peshawar.

Rye grass without *shaftal*, berseem, or clover is excellent green fodder, but is not relished as pure hay. The Military Grass Farms throughout Northern India are now undertaking trials of the fodders mentioned above.

(c) Continuation of trials and demonstrations on the lines indicated.

Implements (a).—Economical Improvement in methods of cultivation.

(b) Present conditions appear to require steel ploughs for "banjar" or neglected and weedy land only, and the Rajah plough has proved its suitability in treating these lands in the North-West Frontier Province.

The Spring tined harrow is appreciated on "barani" tracts.

These seem to be the only implements which are likely to be taken up in the North-West Frontier Province.

(c) In demonstrating the value of the Rajah Plough and the Spring-tined Harrow on suitable tracts.

Entomology (a).—The suppression of garden and farm pests, and the establishment of an instructive collection of insects and agricultural produce.

(b) A museum has been built on the Tarnab farm, and the trained entomologist in charge is collecting and mounting, etc.

(c) In the study of crop pests, especially in the orchards, and in the maintenance of the museum collection.

Poultry (a).—The introduction and distribution of Buff Orpington to the North-West Frontier Province.

(b) Buff Orpingtons have proved to be hardier and better layers and table birds, than the local breeds, and many chickens have been distributed.

(c) In breeding and distributing Orpingtons, village by village.

11—MYSORE.

(Leslie C. Coleman, M.A., Ph.D.)

I.—Agriculture.

The present Farm situated at Hebbal, five miles from Bangalore, is devoted almost exclusively to the chief crops grown in the eastern part of the State. Proposals have been submitted to Government for the establishment of further farms in soil and climatic tracts markedly different from those existing at Bangalore.

Experiments with ragi.—(Eleusine coracana.)—As this is the chief cereal crop grown on the dry lands in the eastern part of the State, work on it occupies a prominent place on the Farm. The experiments being conducted may be divided up as follow :—

1. *Seasonal sowings* to ascertain the most suitable time for sowing ordinary ragi. Originally the sowings extended from April to August, but as the sowings in April and May have yielded uniformly poor results, they have been discontinued. The sowings now extend from June 1st to August 1st at intervals of ten days. The combined results of four crops indicate that sowing in June gives a distinctly inferior yield, while the sowings from the 1st July to the 1st August have shown no uniform superiority for any one of the four sowings. The experiment will be continued.

2. *Cultivation experiments.*—These consist of (*a*) early *vs.* late ploughing, (*b*) wide *vs.* narrow sowing and (*c*) ploughing with improved plough *vs.* ploughing with country plough.

(*a*) The results are uniformly in favour of ploughing as soon after the harvest as possible. (*b*) This experiment in which ragi is sown, in one set of plots, in rows 5 inches apart and, in another set, in rows 10 inches apart has been in progress only two years. The results to date are in favour of the narrow sowing but are not yet conclusive. (*c*) This experiment has been in progress only one year, so no conclusive results are available.

All of the series of experiments will be continued. In addition, an experiment on the use of the sub-surface packer after ploughing is also being carried on.

3. *Manurial experiments with ragi.*—These consist of two series, one on kar or early ragi sown in May and harvested in September; the other on ain or ordinary ragi sown in July and harvested in November. The manures consist of various leguminous crops grown as green manures. In addition, to one series of green manure plots, potash, phosphoric acid and nitrogen in the form of potassium sulphate, basic slag and castor poonac are added in small quantities either singly or combined.

In the case of the early ragi, the green manure crop is put in after the harvest; in the case of the late ragi, it is put in before the sowing. During the last two years, the effect of the green manure crop has become quite marked, in an increase of yield, especially with the late ragi.

The complete series of experiments is as follows :—

(1) *Green manures alone.*—(*a*) Black gram, (*b*) Green gram, (*c*) Sunn hemp, (*d*) Cow pea, (*e*) Avare, (*f*) Avare with ragi, the pods of the avare harvested, the plants ploughed in (*g*) Avare with ragi, the avare, pods and all, ploughed in.

(2) *Green manures with other fertilizers.*—(*a*) Cow pea with potassium sulphate, 60 lbs. per acre, (*b*) Cow pea with basic slag, 150 lbs. per acre, (*c*) Cow pea with potassium sulphate 60 lbs. per acre + basic slag 150 lbs. per acre, (*d*) Cow pea with potassium sulphate and basic slag as above + 230 lbs. of white castor poonac per acre.

(3) To these experiments has been added a set of plots to which cattle manure at the rate of 6,000 lbs. and 3,000 lbs. per acre respectively is being added.

All of these experiments will be continued.

4. *Seed selection by immersion in salt water.*—This method of selecting seed of high specific gravity, has, through two seasons, yielded strikingly good results, giving an increase of 59 per cent. and 56 per cent. respectively over check plots. The experiment will be continued.

5. *Testing of ragi varieties and selecting of pure lines.*—A number of the local varieties are being tested against each other and pure line selection work is being begun. This important work will receive increasing attention from now on.

6. *Rotation of ragi with groundnut.*—This experiment which has been running for only a short time will be continued.

Experiments with paddy.

The results of experiments with paddy, conducted on the Experimental Farm up to 1911, have been published as Bulletin No. 2, General Series, of the Department of Agriculture. On the whole, the results obtained since then have agreed with those already published. Certain experiments, notably those on the use of artificial manures and those on sowing with sprouted paddy, have been discontinued as the results have shown their impracticability.

The experiments on paddy at present under way may be classified as follows :—

1. *Cultivation Experiments.* (*a*) Transplantation *vs.* Broadcasting.

The results still continue to show a variation similar to that noted in the bulletin published. Thus, out of a total of seven crops grown, in four, transplanting has given a larger yield, while, in three, broadcasting has given better results. These experiments are being continued.

(*b*) Deep *vs.* Shallow ploughing. Here also the results to date have not been conclusive, shallow ploughing having given better results in four and deep ploughing in three of the seven crops. The experiment is being continued.

(*c*) Ploughing immediately after harvest *vs.* ploughing immediately before transplantation.

The results of this experiment appear quite conclusive. In only one of the seven crops has the former method given a somewhat higher yield, while in the other six crops, the latter method has given better results, the difference being in most cases quite marked. The experiment is being continued for another year.

2. *Manurial experiments.*—(*a*) The experiments with artificials, as originally planned, have been discontinued. They showed conclusively (1) that saltpetre has no value as a manure for paddy at least under Mysore conditions and (2) that a mixture of saltpetre, basic slag, and sulphate of potash, though increasing the yield somewhat, was used at a great net loss. Another series of experiments will, however, be begun in which saltpetre will be replaced by ammonium sulphate and in which a complete manure, and an application lacking in one of the three constituents, nitrogen, phosphoric acid and potash respectively will be given.

(*b*) Green Manures. Experiments in the use of cow-pea and sunn hemp as green manures which have given, on the whole, good results will be continued with a modification. As two crops of paddy are grown in a year, it has been found difficult to get a good growth of the green manure crop owing to the short time between crops. To avoid this, the transplanting of one of the two crops will be placed three or four weeks later than at present and only one green manure crop will be grown in the year. In this way it is hoped to get more satisfactory results.

(*c*) Green manures *plus* bone meal; green manure *plus* a small quantity of castor cake; and green manure *plus* lime. These experiments have just been begun. Up to the present the addition of raw bone meal to green manure has given a decided increase as compared to the use of green manure alone. The addition of lime has had a depressing effect on the yield, while the addition of a small quantity of castor cake has apparently had little or no effect. These experiments have been running only one year and will be continued.

(*d*) Castor cake as a manure for paddy at the rate of 600 lbs. per acre has for six crops given uniformly an increase in yield but in only three of the six crops has it given a net profit. Experiments will be continued and as soon as plots are available the use of castor along with a phosphatic manure will be tested.

Sugarcane Experiments.

1. *Seasonal planting.*—This experiment which was planned by my predecessor to ascertain through how many months of the year cane could be profitably planted, so as to get the most economic use of improved crushing and boiling machinery, has had to be remodelled, as the original plan necessitated planting cane after cane for a

series of years. The plots have now been doubled in number so as to allow for a rotation and the experiment will be continued as thus modified.

2. *Testing varieties.*—The three chief local varieties of cane are being tested against eight imported varieties as to yield, purity and richness of juice. In addition the same varieties are being tried under conditions of scanty water supply to test their hardiness. This work has just been begun and will be continued until definite results have been obtained.

Minor crops.—Several varieties of cotton are being tested as to their suitability for conditions in the eastern part of the State, where up to the present cotton has not been grown. The results indicate that Combodia can be successfully grown with a small amount of irrigation.

II.—Agricultural Chemistry.

1 Testing of sugarcane varieties as to richness and purity of juice. This work will be carried on in connection with the variety tests on the farm.

2. Determination of soil moisture under different systems of dry land cultivation This work has, owing to lack of suitable soil boring apparatus, been carried on during only part of the year. Soil boring apparatus especially constructed for work in semi arid regions, according to the specifications of Dr. Lyman Briggs of the U. S. Department of Agriculture, has now been ordered, so that the work will, in the future, be carried on throughout the year.

3. Analyses of the soils from various plots on the Farm which have for the last five years undergone different manurial treatment, to ascertain if there has been any increase in plant food constituents and humus.

4. A beginning will be made in preparing a soil survey of the State.

III.—Biology.

Mycology.—The work on *Koleroga* (*Phytophthora omnivora*, var. *arecæ*) which has now been under way for practically five years is progressing satisfactorily. Two experimental gardens are being maintained in areas where the attack is severe. In one of these, an effort (up to the present successful) is being made to suppress the disease entirely. After another season's spraying the garden will be left without treatment to ascertain if the disease has been stamped out. In the other garden, experiments are still continuing as to the best strength of spray and the most economical application. A beginning will be made this year in growing various different varieties of the areca palm which are to be tested later on for yield and disease resistance.

Spraying is being taken up practically by the garden owners. Over seventy sprayers have been purchased by them and during the present season nearly 200 acres of areca garden have been protected by spraying, all at the garden owners' expense. It is hoped to publish a summary of the results of this important work before the end of the year.

2. *Anaberoga of the areca palm caused by fomes lucidus.* Practical measures for the checking of this disease will be taken up during the year.

3. *Leaf rot of coffee* (*Pellicularia koleroga*).—A begining will be made in the investigation of this serious disease of coffee.

4. *Spike disease of sandal.*—Preliminary work on testing the possibility of grafting and buding sandal has been taken up. This work will be continued and it is hoped to make a beginning on the investigatiun of the spread of spike disease.

5. *Ring disease of potatoes.*—The work on this disease will be completed and the results published.

IV.—Entomology.

1. *Grasshopper pests. The jola grasshopper* (*Colemania sphenarioides, Bol*) *and the rice grasshopper* (*Hieroglyphus banian, Fabr*).—Work on these insects consists now in demonstrating practical measures of combating the pests and will be continued each year in areas where they are causing damage. In some places the raiyats themselves are already using the methods recommended by the Department in keeping down these pests.

2. *Kamblihulas or hairy caterpillars* (*Amsacta albistriga*).—Experiments carried out through a period of three years have shown conclusively that light traps are useless at least as far as Mysore is concerned. Hand-picking the moths has proved very successful and is being taken up by the raiyats and their children in infested areas. Experiments on ploughing with improved ploughs to bring about the destruction of pupæ will be continued. A special feature of this work has been the enlisting of childrens' services and the life-history of the pest has been demonstrated in many schools in infested areas.

3. *Green bug on coffee* (*Lecanium viride*).—This serious pest has made its appearance in Mysore during the past year and plans have been made for carrying on a thorough campaign to check its further spread. This will occupy much time and attention during the year.

4. *Pests of stored grains, etc.*—Experiments in testing various methods of freeing stored grains (chiefly pulses) from insect attack and preventing further attack are being carried out and will be continued.

V.—Botany.

A study of the fertilization of ragi has been begun and will be continued. Pure line breeding of ragi and paddy will be taken up.

VI.—Agricultural education.

An Agricultural School with a two years' course based in general on the courses given in American Agricultural High Schools has been established at Bangalore. The course is being made as practical as possible, only so much science instruction being given as is deemed absolutely necessary for an intelligent understanding of agricultural processes. For those students who desire a more thorough scientific training and who appear fitted for it, a more extended course, limited largely to a special science, will be given.

In connection with the school, arrangements will be made for short practical courses in the vernacular on specified subjects, such as sugarcane cultivation, jaggery-making, use of improved ploughs and other implements, etc.

A tentative scheme for instruction in the vernacular in the elements of science as related to agriculture in selected rural schools to be conducted co-operatively by the Educational and Agricultural Departments is being prepared.

VII.—General Agricultural Demonstration.

This will be continued and extended along the lines at present adopted.

(a) The Implement Depot will be enlarged and local Agencies for the stocking of spare parts of ploughs and other implements will be established. Intelligent and trained farm labourers will be more extensively used in giving the necessary instruction to raiyats in the use of improved implements.

(*b*) Green manuring and single seedling transplantation of paddy, which has been introduced by the Department with strikingly good results into the western part of the State, will be extended as rapidly as possible.

(*c*) The use of oil cakes and green manures for sugarcane, which has also been successfully demonstrated, will be extended.

(*d*) The introduction of Broach and Cambodia cottons in areas suitable for their cultivation, which has already reached fairly large proportions, will be extended.

(*e*) Demonstration of early ploughing to conserve soil moisture in connection with ragi cultivation, salt water selection of paddy and ragi seed, etc., will also be taken up.

12.—KASHMIR.

(RAM GOPAL, M.A., M.R.A.C., P.A.S.I., N.D.D.)

Work in progress.

Reference should be made to the programme for 1912-14 (wrongly printed 1912-13).

1. The aim of varietal experiments with various crops has been to discover their varieties best suited to Kashmir. Baber (Kashmiri) Paddy, Japanese Small Groundnut, Early Green Soy-bean, Stowell's Evergreen Maize and Two-rowed Duck-bill Barley were tried on a larger scale. Paddy, maize and beans gave better results than those obtained on small experimental plots. Groundnut and barley gave slightly inferior results. These experiments will continue.

2. The cultivation experiments with paddy have consisted of the planting of different numbers of seedlings together. No definite results have yet been obtained.

3. Artificial manures imported into Kashmir from abroad would be too costly to be profitable, and the manures experimented with so far have all been locally obtained with the exception of Nitrate of Lime. This fertilizer continues to be tried in view of the project of its being manufactured in Kashmir with the electric power available. With the local manures it is mostly a question of what is near at hand, for where carriage by water is not possible the cost of transport is considerably increased. Green manuring is being tried and it has to be seen how far it needs being supplemented with other manures so as to give the best results. Upto this time farm yard manure has produced the best yields of wheat and barley; sweepings have done so with mustard and maize; and horse-dung with "Juar." Manurial experiments with paddy, tobacco and groundnut have been started. Bone manures will also be tried.

4. Plots under the four-course rotation were found to be uneven and they have now been properly levelled and put under the rotation crops. Among two-year rotations wheat has given better results after "urd" and gram than after beans and peas. Among "Dofasli" rotations wheat gave better results after "urd" than after "moong," sunhemp, beans and peas.

5. Among miscellaneous crops "juar" and lucerne have been grown for fodder; and "arvi" and gram have been newly introduced. Both juar and lucerne fodders are better than paddy straw in comparison to which their yields have been twice and four times as much respectively. Juar did not produce good seed and its seed is imported every year for sowing purposes. Lucerne does not ripen its seed here: its one sowing is sufficient for more than six years. "Arvi" yielded a crop equal in quantity to that of potatoes (in a previous year), but fetched three times as much money as the latter had done. Lucknow musk-melons are being tried and seem to grow well. Cigar tobacco has been grown, but it has not been tried for cigar manufacture. Efforts will be made to enlist the co-operation of some cigar manufacturing firms.

6. Among fibre experiments jute was grown twice, but the seed did not germinate. Yarkand Bhang once grew successfully, but the whole crop was taken by the Customs and Excise Department, for which it had been grown and the fibre was not extracted. Other fibre experiments are in progress.

7. The implements which have so far proved to be improvements on methods already in vogue in the Valley are Chaff-cutter, Maize-huller or sheller, Winnower, Watt's Chain Plough and Karah—a levelling implement. With the Chaff-cutter three times as much work was done as by manual labour with a "Ramba." The Maize-sheller separated the grain from cobs at the same rate as is obtained by beating the cobs with sticks, but under these nearly 33 per cent. of the grain gets broken. The Winnower using up three men's labour cleaned twice as much grain per hour as four men clean by working with a sheet of cloth. Watt's Chain-Plough went 8 inches deep as compared to the 5 inches of Kashmiri plough and turned the furrow which the Kashmiri plough does not do. The area of land ploughed in 8 hours was the same in both cases. Two men and 4 bullocks working a "Karah" did as much levelling work as 20 men do with "bels" and baskets. None of these implements have yet been successfully introduced among the cultivators, but such methods for attaining this end as can be employed with the available funds and staff will be adopted. The Chain-harrow was tried for the first time this year, and the harrowed plot yielded twice as much wheat as the plot next to it which was not harrowed. Endeavour will be made to use it on cultivators' fields next year in as many villages as possible so as to demonstrate its utility to a wide circle of men.

8. Seed-distribution so far has been on an inconsiderably small scale, and that without any supervision after the seeds left the store. An increase in the quantity of seed to be distributed depends on more land, and supervision on more assistance. The present assistant staff consists of only one Farm Manager. The question of acquiring more land is under consideration.

9. For seed-distribution and the introduction of implements which have proved successful among cultivators, the help of co-operative societies is much needed, but these have not been started in Kashmir as yet.

10. Very recently mistletoe (a parasitic plant) was noticed as a regular pest on Walnuts in Handawara where the Kashmiris look upon it as dwarfed branches of the tree itself. Also smut of wheat was noticed in the same Tehsil. It is proposed to deal with such cases by issuing printed leaflets, and demonstrating remedial methods to Patwaris, Kanungos, Zaildars and Numberdars who can afterwards supervise the same in their respective villages.

11. Some cross-bred cattle have been obtained by using a Hissar bull and a cross-bred bull Hissar (x Kashmiri) on Kashmiri cows, but it is a very small attempt yet towards the production of better cattle in Kashmir than found at present. The prohibition to export cattle out of the State territories and the fact that the Kashmiri butchers cannot buy them raises difficulties in the way of cattle-improvement on best economic lines which require that undesirable animals should not be allowed to breed, but should be fattened off and sold. Only such breeds are therefore needed as will produce powerful draught bullocks as well as good milking cows. As a precaution against the undoing of any success attained in this line, good breeding cows will be sold within the State territories only under conditions to be framed so as to prevent their being crossed promiscuously and producing degenerate issue. A herd-book for such animals and their progeny will have to be started.

12. The Agricultural and Cattle Show is now an annual institution. The Experimental farm is too far from the show ground for people to go there for attending demonstrations. The land proposed to be acquired for a supplementary farm, however, is very near, and it will be very easy to obtain a good attendance of visitors there.

P 2

New work.

I. The fruit Industry in Kashmir needs special attention and this will be chiefly attended to—

(1) The State Gardens (other than pleasure gardens) under the control of this Department will be developed into so many demonstration areas where fruit-trees of best varieties for the locality will be grown on modern scientific lines (as regards distance apart, pruning, cultivation, root-pruning, weathering of roots, irrigation, etc.) and wherefrom plants may be issued to the villages around.

(2) For the proper marketing of Kashmir fruits in the plains of India, picking at proper times, and better packing methods will be introduced; also means sought for transporting the fruits safely, cheaply and quickly. At present fruits in Kashmir are plucked much too early, so that they do not develop their full flavours.

II. Improvement of the pleasure gardens, specially the Nishat and Shalamar gardens.

III. Starting of a central Fruit Experimental Farm within easy reach of the Pratap Model Farm and the Nishat and Shalamar gardens, if the question of acquisition of land gets settled in time.

IV. Extension of work on rice in the direction of separating and classifying the types grown in the valley, if the land above-mentioned is acquired and necessary staff sanctioned.

V. Starting of Supplementary Farm on land near the Agricultural showground. The question of acquiring the land concerned is already under disposal of the higher authorities.

VI. Starting of an Agricultural station in the Karnah Tehsil for introducing better varieties of maize which forms a much more important crop there than in the valley, and for experimenting with fruit-trees there. This depends on land being acquired and sufficient staff being available.

VII. Extension and reorganisation of the Department on which the fulfilment of the programme very much depends. The Assistant Scientific staff at present consists of only one Farm Manager.

(1) If staff and funds are available, butter-making on the farm will be started for demonstrational purposes.

(2) Introduction of good varieties of water-nut (Singhara) and some new varieties of Lotus in the lakes.

(3) Introduction of best walnut-trees into localities where inferior walnuts are growing.

(4) Supervision of arboriculture areas in Srinagar and in the valley.

(5) The getting up of a herbarium, a collection of agricultural products and an adequate library as funds allow.

13.—BARODA.

(M. A. Sitole, B.A., M.R.A.C.)

I.—Baroda Model Farm.

1. Varietal Experiments.

Tobacco.—Of these, none of the exotic varieties are superior in any remarkable degree. *White Burley*, however, has given very good results at Nadiad and the same will be tried on this farm.

Cotton.—Of the cotton varieties, *Lalio* is found to be the best in out-turn so far. The ginning percentage, however, has tendency to be reduced on acclimatization. Tests of all the cottons grown on the Farm, acclimatized and fresh, are being made to determine this factor of the exotics. *Cambodia* seems to be by far the most suited. The same tendency of deterioration of ginning percent is to be also observed here; the first seed giving cotton with 35 per cent. ginning; the one grown from seed one year on the Farm giving 33 per cent.; while under best conditions, it is known to yield 38 to 40 per cent.

Ground-nuts.—Both the *Small Japanese* and *Spanish Peanut* types are suitable for extensive cultivation. In spite of the heavy cost of cultivation they leave fairly good profits. Attempts are being made to reduce the seed and harvesting charges without materially reducing the outturn. Of the above two, the Spanish Peanut has a tendency to get reduced in size in nuts. No such occurrence happens with small Japanese. The latter is also a better fodder yielder of the two. Of the late varieties, *Tamboo* has given very good outturns, and where irrigation facilities are available, the cost of harvesting could be considerably reduced by harvesting after softening the field with irrigation. Two new varieties—*Pondicherry* and *Big Japanese* are being tried this year.

Wheat.—Of the wheats, *Spelt wheat* though giving fairly good returns, does not leave sufficient profit. The best paying of the four types tested with is *Pissi*. This year, *Australian wheat*, one of the early varieties and a good yielder besides, is being tried.

2. Manurial experiment on Tobacco.

Experiments with regard to the use of *castor cake* as top-dressing have given fairly good results. This practice of using castor cake, however, is unanimously opposed by all cultivators who allege that the quality gets considerably spoiled.

Use of green manures of *sann* has so far given only negative results. In many cases it appears to be due to the want of assimilation of the organic matter by the soil and this year Sann is replaced by *Guwar* and results will be noted.

As regards artificial fertilizers, last year's results point to the fact that applying fertilizers before transplanting is better than after. The comparative results with farm yard manure alone have not given consistent results in the duplicate plots. The experiment is being repeated.

Cotton.—Manurial experiments with this crop are with *farm yard manure*, *Mawra refuse* and *poudrette*. Of these, the pondrette plot has given by far the best outturn.

Another experiment with cotton for avoiding danger of frost is starting the cotton in May with irrigation. Four types, *viz.*, *Lalio*, *Navsari*, *Ghogari* and *Cambodia* are used. The frost insurance may be judged from the fact that before January 1st 1913, Cambodia started with irrigation had yielded 600 lbs. as against only 120 of Lalio, the earliest of the herbaceum types used in the experiment. In total yield, however, Lalio is very strong competitor and Cambodia, the former, yielding 1,400 lbs. as against only 1,300 of the latter. For frost insurance, however, Cambodia easily leads.

Sugarcane.—The crop in 1912-13 having suffered very badly from insect attack, did not give any results. So far nothing can be said about this year's results. From observations made during the growth of the crop this year, however, the following points are worthy of notice :—

(1) That the previous cropping has a remarkable effect on the cane that follows.

(2) That the insect attacks are less destructive in cane that has made vigourous growth.

(3) Early vigourous growth must be attempted if we are to avert the severity of the damages from white ants and sugarcane borer.

3. *Improved Implements and Machinery.*

The B. T.-2 plough is being slowly taken up by the cultivators. The cost of the shares which are soon worn out, however, is somewhat of a difficulty.

Other new implements tried are the *disc harrow, Planet Junior Hand Hoes* and *McCormick cultivators.* The disc harrow has given such a satisfaction in all directions, whether quantity of work or quality, adjustability and use for various purposes, that it is decided to demonstrate its use to the cultivators. The cost of this implement is Rs. 100, in round numbers. Attempts will be made to find a suitable implement, within the means of cultivators, and which would give as good and swift work *as this costly machine.*

The Planet Junior Hand Hoes are equally appreciated by the cultivators and an order for two dozen of these has already been placed with the agents.

The McCormick cultivators are so far only a few months old, but *promise to be useful in a variety of ways.* Their possibilities will be further tested before recommending them to the cultivating public.

4. *Distribution of Seeds.*

The Farm has distributed about 10 mds. of early ground-nut varieties. The results are being awaited with great interest.

5. *Farm Demonstrations.*

Three big demonstrations were held on the Farm ; attention of the visitors being chiefly drawn to the work of the B. T.-2 plough, Hand Hoe, Winnower, early Ground-nuts, Lucerne, irrigated cottons and Poudrette manures.

II. Jagudan Farm.

6. Jagudan Farm in Kadi Prant (North Gujarat) has been opened since 1910 as a demonstration Farm. The average type of the soil of this tract being sandy and uneven, the first step towards improvement has been taken by bunding and terracing and by supplying humus by way of green manuring and applying Farm Yard Manure. The Farm is divided into suitable plots and is now thoroughly equipped.

7. Improved implements such as B. T.-2 ploughs, hand Chain Pumps, spring and Disc harrow, Planet Junior hoes and chaff cutters are used on the Farm and are demonstrated to the cultivators of the District.

8. New crops such as potatoes, groundnuts, Cambodia, Buri and Lalio cottons and English vegetables and lucerne grass in addition to the existing crops of the District are successfully grown and demonstrated to the cultivators.

9. Batches of cultivators from 150—200 are invited from time to time and lectures regarding the different methods of general improvement in agriculture are given. In fact this farm is being made a medium for introduction of improved implements, good cultivation and new and valuable crops amongst the cultivators.

10. A vernacular class for imparting practical training in agriculture to the sons of agriculturists will be opened on the Jagudan Farm from November 1913.

III.—Songadh Farm.

11. Songadh Farm on the Tapti Valley Railway serves as a teaching Farm to the aborigines—Bhil boys and girls—of the Jungal tract of the State. All the labour of the Farm is done by the boys and the girls. Excellent crops of paddy, jawar, cotton and ground-nuts, etc., are grown on this Farm. The net income of the Farm is over one thousand rupees annually.

IV.—*Reclamation of Ravines by Dams and by Terracing.*

12. As recommended by the N.-W. P. Agricultural Department's Bulletin No. 17 on "Agricultural Improvements" (pp. 8 and 9) and by the Agricultural Ledger No. 16 on "Embankments in Agriculture" (page 3), this Department gave in 1909-10, 35 Bighas of ravines land to one enterprising cultivator free of cost, with certain concession as to its future assessment, to be reclaimed as per instructions in the above bulletins. In two years' time, the cultivator reclaimed all that piece of land by bunding with masonry and terracing the land. The result was that he actually got in three years' time all the money back he had spent on recommendation, by growing beautiful crops of tobacco. This attracted the attention of the neighbours who came forward with the demand of land on the same concessions, and the Baroda Government at the recommendations of this Department gave 619 bighas and 8 vasas of land to 39 cultivators of the villages Ranoli, Padamala, Sakarda, Nandesari and Fajalpur of the Savli Taluka, and of the village Dhanora of the Baroda Taluka. The bunds are constructed and the terracing is in progress. There are yet about 300 bighas of land in demand which will be given in due course of time. It is hoped when these works are completed and lands made fit for agriculture, there will be a demand for thousands of bighas of useless ravine land in the State.

V.—Improved Implements.

13. Twenty-eight Ransomes' ploughs and 17 Chain Pumps and other minor implements were sold by the Department in 1911-12.

85 Ransomes' Ploughs and one Chaff cutter were sold by the Department in 1912-13.

Efforts will be made to introduce them over a larger scale amongst the cultivators.

VI.—Well-boring.

14. In all, nineteen boring machines began the work in 1911-12 The total number of wells bored was 119 out of which 94 wells were successful and obtained 335 *koses* of new additional water.

In 1912-13, twenty boring sets bored 204 wells, out of which 185 were successful, giving 565 koses * of new additional water.

Well-boring will be continued.

15. Owing to the ample supply of water in wells through successful boring, many enthusiastic cultivators have felt the necessity of installing Oil Engines and pumps for extensive irrigation. The Department has obtained sanction of Rs. 42,000 for advancing tacavi by way of help to them for the purchase of oil-engines and pumps through this Department.

VII.—Publication.

16. The quarterly magazine in Gujarati will be continued and its free distribution will be increased from 2,500 to 3,500 village boards and village libraries.

* (NOTE.—One kos is equal to 1,800 to 2,000 gallons of water.)

VIII.—Distribution of Seeds.

(a) *From the Head Office.*

17. In 1911-12, 22,000 lbs. of the best selected Hybrid cotton seed from Surat Government Farm were sown in 2,405 bighas † in a few selected villages in Naosari Prant and the produce was sold to the Bombay Cotton Syndicate at 5 per cent. more than the then existing market price.

In 1912-13, 1,58,000 lbs. of Hybrid cotton seed in the few selected villages of Velachha, Kamrej, Palsana and Vakal Talukas of the Naosari Prant were sown in 12,500 bighas of land and the produce sold to the syndicate at 5 per cent. more than the existing price for local cotton on the day of sale.

8,000 lbs. of the above cotton seed was sold without any guarantee as to the additional price.

18. 7,900 lbs. of Cambodia cotton seed was supplied to the people of Kadi Prant from the Mysore and the Madras Agricultural Departments and from the Baroda and Jagudan Farms.

Distribution of improved seed will be continued.

(b) *From Seed Depôts.*

19. The Seed Depôt at Vakal which has been found considerably serviceable by way of distributing best selected seeds of local crops to the agriculturists of the most backward classes who form the majority of Vakal Peta-Mahal, distributed 73,500 lbs. of seeds during the last two years.

20. The seed depôts attached to the Baroda and Jagudan Model Farms collected and sold 6,238 lbs. and 900 lbs. of selected seeds respectively during the last two years.

All these three Seed Depôts will be continued and made more useful to the ryots.

IX.—Entomology.

21. Insects of major importance (besides number of other minor ones) that have been found till now to exist in the Baroda State, are: (1) Hairy caterpillars (katra). (2) Boll-worm of cotton. (3) Tobacco stem-borer. (4) Stem-borer of sesamum. (5) White-ants. (6) Ground grass-hoppers; and (7) Sugarcane borer.

Definite efforts will be made to ascertain the adaptability and applicability of the knowledge to varying local conditions.

22. Methods of treatment suited to the local conditions in general have been found out for all excepting white ants and ground grass-hoppers.

23. Advice has been given to cultivators, about dealing with their foes, by way of (a) circulating ten pamphlets and occasional leaflets; (b) field demonstrations at the Baroda Model Farm and cultivators' fields of 8 Talukas and encouragement by way of competition prizes; and (c) other miscellaneous efforts such as night gatherings in villages, lantern lectures, responding the inquiries made by cultivators and others, etc.

All these means of inspiring interest among cultivators will be continued on more definite lines.

X.—Lac-culture.

24. An organised effort is being made to cultivate lac on Babul trees. Help of the Forest Department of Sindh is being taken to attain a success in this line.

XI.—Sericulture.

25. Eighteen mulberry silk crops were taken at the Naosari Sericultural Station during 1911-12 and 1912-13, with a fair success. Two small crops of eri-silk worms were also taken at Naosari, but one of them failed through excessive heat.

Sericulture will be pushed on and gradually introduced amongst the Parsi and other people who do not object to killing of insects.

XII.—Ericulture.

26. Sixteen crops of eri-silk worms were taken at the Baroda Sericultural Station, out of which twelve were successful.

27. Experiments are being made to watch the effect of plucking the leaves of castor for the purpose of rearing eri worms, on the yield of seed. The data obtained during the last two years point out that by plucking the leaves, the yield of the seed is diminished by 7·5 to 70·0 per cent.

Efforts will be made to take eri-crops as large as possible, to demonstrate and introduce the industry among the ryots, making it a paying concern.

XIII.—Protection of cattle from pests and diseases.

28. There are five Veterinary Dispensaries at Baroda, Naosari, Mehsana, Pattan and Amreli. The five Veterinary Surgeons in all treated during the years 1911-12 and 1912-13, 4,210 animals at their dispensaries, and 8,507 animals while moving on tour in the Districts and inoculated 6,417 cattle with serum against rinderpest that prevailed during the famine of 1911-12. A number of 1,773 famine-stricken cattle were saved through the utmost care and good supervision of the Veterinary Surgeons stationed at the Cattle camps in Naosari Division during the famine.

In fact, these institutions are doing a good work. A scheme for the extension and better equipment of the Veterinary establishment is under consideration.

XIV.—Agricultural Associations.

29. The formation of the Kadi Prant Khedut Sabha (District Agricultural Association) in April 1913, has been the fruit of the organised effort of this Department assisted by the Local Boards. Through the medium of this Association which has got a number of about 1,000 members, it is intended to introduce practical improvements in agriculture among the ryots of Kadi District. This year, distribution of about 7,000 lbs. of Cambodia cotton seed and of 36 Ransomes' B. T_2 ploughs has been made through the Association. A travelling Agricultural Graduate has now been specially engaged to demonstrate to the ryots the use of various improved implements and machines purchased by the Association. He will move from place to place in Kadi District and try to impress the ryots by the Demonstration.

Similar efforts to form Agricultural Associations will also be made in other districts of the Baroda State.

† NOTE.—One bigha is equal to 24 gunthas.

14. TRAVANCORE.

(N. KUNJAN PILLAI, M.A., B.Sc., PH. D.)

There are three Experimental Farms in the State, one at Trivandrum for experiments with banana, sugarcane and exotic crops, such as groundnut, cotton, etc.; another at Kottarakaray for experiments with root crops, such as cassava, yams, etc., and pepper; and a third at Alleppey for experiments with the cocoanut palm. There is also a Cattle-Breeding Farm and a Silk Farm at Trivandrum and a Demonstration Farm at Quilon mainly for the cultivation of Guinea-grass. It is proposed to open an Experimental Farm for paddy at Nagercoil in the near future. Experiments with paddy are now being conducted in royts lands.

1. Experiments with crops.

Paddy.—Manurial experiments have been going on for the last 4 years. It has been found from these experiments that the application of 600 lbs. of oilcakes and 240 lbs. of bone meal together with a top-dressing of 100 lbs. of saltpetre per acre gives very good results. Attempts are, therefore, being made to popularise the above method of manuring.

Experiments have also been started to test the value of saltpetre, ammonium sulphate, nitrolim and nitrate of lime as a source of nitrogen to the paddy crop, and also to test the manurial value of local manures such as oilcakes, fish refuse, etc., for the same crop. These experiments will be continued for a few years.

The conditions in Travancore do not, as a rule, admit of the adoption of the method of ploughing into the land leguminous crops as green manure. There prevails, however, a common practice of applying the green leaves of several species of trees for the paddy crop. After the Paddy Farm is opened in Nagercoil, experiments will be started to ascertain the relative manurial value of the different kinds of leaves.

Varietal experiments with some local and exotic varieties of paddy are being carried out. These experiments will be continued on an extended scale after the opening of the Paddy Farm in Nagercoil.

Experiments conducted so far have shown that Banku Paddy is a better yielder than most of the local varieties, and consequently this seed is being distributed among the ryots gratis. This work will be continued.

Recently the seeds of some new varieties of paddy have been got down from the Central Provinces and a special variety of salt water paddy from the Philippine Islands. The trial of these varieties will be continued for 2 or 3 years.

Experiments on single seedling transplantation of paddy having produced satisfactory results, have been discontinued, and attention is now directed to the popularisation of this system.

Cocoanut.—The Cocoanut Farm at Alleppey is devoted to the trial of different varieties of the cocoanut palm. The farm consists of about 8 acres, and the whole of it has been planted with 15 seedlings each of 30 local and exotic varieties. The farm will have to be maintained for a number of years before any results can be expected.

Manurial experiments have been carried out with local manures, such as oilcakes, ashes, fish refuse, etc., and a mixture of 720 lbs. of oilcakes, 2,000 lbs. of ashes, 200 lbs. of fish refuse, 80 lbs. of common salt and 1,000 lbs. of slaked lime per acre has been found to give very good results. With a view to popularise these manures, manure depôts have been established in some parts of the State, and they are doing very good business. The depôts will, therefore, be maintained for some years to come.

Experiments with artificial manures, supplied free of cost by the Agent of the Potash Syndicate, have also been started in about an acre of bearing cocoanut trees belonging to a private gentleman. These experiments will be repeated for several years.

An infectious root disease has been doing havoc among the cocoanut trees in some parts of the State during the last 35 years or so. Dr. Butler, Imperial Mycologist, once visited Travancore and published a report on this disease (Bulletin No. 9 of the Agricultural Research Institute, Pusa). Owing to the absence of a specialist, it has not been possible to conduct any further mycological investigations, but some practical steps have been taken to check the spread of infection and to bring the disease under control as suggested by Dr. Butler. This work will be continued for some years.

Sugarcane.—Varietal experiments have been in progress for the last 3 years, and have shown that B. 208 and Red Mauritius are generally the best varieties; but under certain conditions the red canes are found to be better. These experiments will be continued for a few years more.

Manurial experiments, chiefly with local manures, will be started during the coming year.

Cassava.—Varietal experiments have been conducted for the last 2 years and will be continued for some time to come. Definite results can be expected only after some years.

Manurial experiments with artificial and local manures have been started this year and will be continued for a number of years.

Pepper.—Varietal experiments are in progress. No results can be expected for some years to come.

Yams.—Experiments are confined to the testing of the possibility of improving the yield by the selection of seeds. Work on this line was started last year and will be continued for some years.

Fodder crops.—*Cholam* and Guinea-grass are the two fodder crops that are being experimented with. There is ample facility for the cultivation of these crops in the State. Experiments with Guinea-grass have shown that about 6 to 7 tons of green fodder can be obtained from an acre in a year without irrigation. With irrigation the yield may double itself. Experiments with *Cholam* and Guinea-grass will be continued, and an attempt will be made to popularise their cultivation in the State.

2. Cattle-breeding.

Breeding operations are being conducted in the Cattle-breeding Farm at Trivandrum, the object being the production of good milch cows and strong draught-bullocks suited to local conditions. Owing to the absence of any breed of cattle worth the name in Travancore, attention is directed chiefly to the acclimatisation of some of the well-known South Indian breeds, such as Ongole, Kangayam, etc., and to the production, if possible, of cross-breeds between local cows and Ongole and Kangayam bulls.

The Department owns a number of breeding bulls of the Kangayam and Halligarh breeds, which are being sent round from village to village for covering native cows. More than 1,500 cows have been successfully covered by these bulls during the last four years. It is proposed to buy more breeding bulls during the coming year for this purpose and continue the work on a larger scale.

3. Sericulture.

A Silk Farm was opened in Trivandrum 3 years ago, with a view to experiment on silk cultivation. The cultivation of mulberry and *Eri* silk is found to be practicable in Travancore. The results of the experiments being

satisfactory, attempts are now being made to popularise the industry, especially the *Eri* silk industry, in the State. Work on these lines will be continued until the industry has taken a firm hold in the country.

4. Agricultural Chemistry.

The permanent Agricultural Chemist is now undergoing training in the Agricultural Research Institute at Pusa, and is expected to return by the end of 1913. In the meanwhile a substitute has been appointed and he is engaged in the analysis of soils manures, sugarcanes, and milk for the ryots as well as for the department. The permanent Agricultural Chemist, on his return, will be engaged in the analysis of the different kinds of soils from the various parts of the State, so as to have a complete and permanent record, and also in the analysis of the different kinds of green leaves used as manure so as to ascertain their relative value.

5. Entomology.

An Agricultural Inspector has been deputed, at the cost of the Darbar, to the Agricultural Research Institute at Pusa for undergoing training in Entomology. He will return in about 3 months and engage himself in the study of the life-history and characteristics of the insect pests and the collection of the common insects of the State.

6. Miscellaneous works.

Under this head are included all those efforts of the department for bringing scientific knowledge within the reach of the ryots. They are chiefly the following :—

(a) Demonstration of the use of improved agricultural implements and machinery, such as iron ploughs, chaff cutter, winnowing machine, seed-drill, etc. Among iron ploughs the "Meston" plough is liked by the ryots most. The department stocks a number of this plough and sells them to the ryots. During the last two years nearly 250 ploughs have been sold in this way.

(b) Trial of new seeds and manures in ryots' lands. In addition to the trials made by the department, seeds and manures are distributed in small quantities to the ryots gratis. As a result of such work, groundnut, an exotic crop, is now being cultivated in several parts of the State, the cultivation of sugarcane is steadily extending, oilcakes are being freely used as manure, the question of manuring the paddy crop and the cocoanut palm is receiving better attention, and liming is becoming a common practice.

(c) Publication of Leaflets. Leaflets are being published from time to time on agricultural matters, and copies of these are being distributed broadcast among the ryots. So far, 51 leaflets have been published. The leaflets and lectures published by the department till the middle of 1910 have been issued in book form and nearly 3,000 copies of this book have been sold to the ryots for a small price. The leaflets and other agricultural matters published since then will also be issued in book form at an early date.

(d) Contribution of articles on agricultural matters to the vernacular newspapers.

(e) Delivery of popular lectures on agricultural subjects by the circuiting officers.

In addition to the continuation of work on the above lines, it is proposed to publish a quarterly agricultural journal in the vernacular by the department from the beginning of the next official year.

APPENDIX—C.

(1)

Subject VII.—Notes on measures taken by the Provinces in connection with the Sugar Industry on the lines approved by the Board of Agriculture in 1911.

BENGAL.

So far as the newly constituted province of Bengal is concerned, under present conditions I recommend the capitalist to have nothing to do with the Central Factory System.

These conditions are :—

(1) *Area under cane is too small.*—When we consider the area under cultivation in each district and the small area devoted to cane, it becomes very evident that economical reasons are against extension of cane cultivation in Bengal. The following table showing the area under cultivation in each district of the province and that devoted to cane, explains this :—

	Net area cropped during the year in Bengal.	Are a under sugarcane.		Net area cropped during the year in Bengal.	Area under sugarcane.
	Acres.	Acres.		Acres.	Acres.
24-Parganas	979,200	3,800	Brought forward .	12,031,300	126,400
Nadia	722,500	6,000	Darjeeling	174,600	100
Murshidabad	579,800	3,800	Rangpur	1,570,400	13,600
Jessore	1,112,500	3,400	Bogra	469,900	20,000
Khulna	873,300	1,300	Pabna	774,200	10,000
Burdwan	848,700	24,100	Malda	775,800	200
Birbhum	763,700	8,500	Dacca	1,255,800	16,100
Bankura	536,600	10,500	Mymensingh	2,517,300	7,500
Midnapur	1,767,800	3,000	Faridpur	895,000	6,400
Hooghly	371,100	7,200	Bakarganj	1,670,200	11,800
Howrah	168,700	7,000	Chittagong	632,900	4,800
Rajshahi	924,300	13,300	Tippera	1,123,400	4,000
Dinajpur	1,415,800	30,000	Noakhali	1,015,200	700
Jalpaiguri	967,300	4,400	Chittagong Hill Tracts . .	85,100	1,000
Carried over .	12,031,300	126,400	Total .	24,991,100	222,600

The reasons for this are various. Excellent cane can be grown in most districts of Bengal except Burdwan Division without irrigation. Cheap white Java sugar, however, can be obtained in every village at Rs. 8 to 10 per maund. Owing to the small area under cane, good prices are obtainable for *gur*—even Rs. 7 per maund being obtained. This precludes any chance of the cultivator growing cane for a factory. If the area under cane increases the price of *gur* drops to Rs. 4 per maund very quickly. When the price of *gur* drops below Rs. 4 per maund the cultivator soon takes to jute in preference to cane, because cane occupies the land a whole year, requires heavy manuring, constant cultivation and much labour, while jute occupies the land only four to five months, and can be followed by a *rabi* crop. Besides, the prices obtainable this year for jute fibre (August 1913) are Rs. 10 to Rs. 13 per maund. There is, therefore, no inducement to give up jute for sugarcane (taking 20 maunds fibre per acre as a good crop). The above remarks are for land suited to cane, jute and *aus* paddy, but it must not be forgotten that out of a total area cultivated in Bengal of 25 million acres, there are 16½ million acres under winter rice. This crop grows on land that is subject to flooding and constant water-logging, and is not suited to sugarcane. There are 5½ million acres of autumn rice however, but this area under present condition is more likely to go under jute than cane. Nevertheless if the *raiyats* of Bengal desire, there is plenty of land for the expansion of cane cultivation.

(2) *Ignorance of the cultivator.*—Unless the cultivator co-operates with the factory, the sugar factory system is bound to fail. This will never take place till the ignorance of the cultivator has been removed by education. Out of 46 millions of people in Bengal, 35½ millions are engaged in agriculture. Of these 35½ millions, 30 millions are cultivators, 3 millions are farm servants and labourers, while 1½ millions are maintained by incomes from agricultural land (O'Malley). Of the total population only 7½ per cent., are literate. The literate people are generally very philosophical. Cane cultivation means very hard work. The distrust of the illiterate is extraordinary. They do not even trust cultivators in the next village, so co-operation seems out of the question for a very long time. Unless there is co-operation amongst the cultivators of a whole tract I do not see how a central sugar factory can be a success. If Government were to acquire a tract of land for the purpose they would have to acquire such a large area to obtain the requisite amount of cane land, that it would become politically impossible. So many people would be driven out of their homes and land that the scheme would be unpopular from the very beginning. Altogether then in Bengal the central sugar factory system is such that it should come from the people and not from the Government.

Sugar manufacture in Bengal is different to the manufacture of hessians. Fibre can be carted long distances, baled and stored for months, while the factory would work all day and night throughout the year if it could. Cane cannot be carted far without loss nor stored, while the manufacturing season is very limited (three months).

Accordingly I am firmly of opinion that unless the jute trade dies, unless a high import duty is placed on sugar and unless the people are better educated, conditions will not arise in Bengal suitable for the economical working of the central sugar factory.

I think, therefore, that so far as cane is concerned, our department only needs deal with the crop from the *gur* standpoint, *i.e.*, with the improvement of the outturn per acre and with the more economical manufacture of the *gur*.

(*a*) *Mechanical.*—So far as mills and boiling plant are concerned, these may be left to the sugar engineer The cultivator of Bengal does not care about purchasing a cane-crushing mill and a boiling pan. He prefers to hire these implements at so much per day. When the sugar engineer has obtained definite improvements on the present implements we can bring them to the notice of the Bengal *raiyat*.

(*b*) *Agricultural.*—Taking into consideration the spending capacity of the *raiyat*, we can demonstrate the benefit of growing cane in lines to facilitate cultivation and drainage, while by cultivating better varieties of cane and manuring, we can teach him how to improve his outturn of *gur* per acre.

(*c*) *Botanical.*—When the botanist makes over to us new varieties of canes we can test them to see if they are suitable for Bengal.

(*d*) *Marketing.*—So far as marketing is concerned, we may leave that to the trade.

The following statement shows what results were obtained at the farms in Bengal in 1913 :—

Farms.	Area under sugarcane planted and ratooned.		Yield per acre.
		Acres.	Mds.
Dacca	Planted	5¼	61¼
	Ratooned	5¼	40
Chinsurah	Planted	1·87	56
	Ratooned	·6	33
Rajshahi	Planted	1⅔	72¼
Rangpur	Do.	¼	102

These results have been obtained from thick canes (striped Tanna, white Tanna, Barbadoes, Mauritius, Java and Dacca Ganderi) grown in lines (ridge and furrow) and manured with cowdung 200 maunds *plus* 20 maunds castor-cake per acre, while the *gur* was manufactured by means of the three cane-roller mills and the ordinary boiling pan. The average price obtained for the *gur* was Rs. 5 per maund, which gives a very fair return per acre.

In previous years we have obtained very heavy yields on small plots, but I consider such figures misleading, so have not included them in this report.

The only remark I have to make on the above figures is that a small plot of ⅛th of an acre of cane can be easily guarded and fenced. The damage done to thick canes by jackals is enormous. This means constant care and attention, which the *raiyat* is not inclined to give.

BIHAR AND ORISSA.

Sugarcane Station in North Bihar.—Since the recommendations on the Indian sugar industry made by the Board of Agriculture at its meeting held at Pusa in November 1911 this Government has had under consideration the establishment of a sugarcane selecting station in the sugar tract in North Bihar. The station is intended to be used primarily as a cane selecting station. Its secondary purpose will be to give an object lesson in the proper method of cane cultivation. It will work in conjunction with the cane breeding station at Coimbatore under Dr. Barber and will be used for testing canes for introduction into Bihar.

With a view to select a suitable site for the proposed station Mr. Heycock, Director of Agriculture, Bihar and Orissa, and Mr. Coventry, the Agricultural Adviser to the Government of India, were on tour in the principal cane-growing districts in North Bihar in September 1912, and selected Maniarah in the Saran district. In May 1913, Mr. Milne, the Officiating Director of Agriculture, visited the place with Mr. Milligan, Imperial Agriculturist, Pusa, and Mr. Quinlan, to make a detailed enquiry regarding the proposed station, found that the Sipaya, zirats, some 3, miles north and west of the head factory at Maniarah and 5 miles from Sasa Musa, were more suitable for the station than Maniarah and submitted a report to Government, who are now considering the question of site, acquisition and administration.

Sugarcane Experiments carried out at Sabour.—In 1909 a set of the varieties of sugarcane found in Bengal was collected by Mr. Taylor, the Agricultural Chemist, and Mr. Woodhouse, the Economic Botanist to the Government, commenced the work of determining the characters of agricultural value and those of value to the Botanist for purposes of classification in co-operation with the Agricultural Chemist, Mr. Taylor, who undertook the chemical side of the question. In 1910, single plants were selected of each variety and since then all observations have been made merely on these lines. The work is now being brought to a close and the single plant cultures will then be ready for handing over to the proposed sugar station in North Bihar for making trials of yield on a field scale. Mr. Taylor has made a great many determinations of the woody matter of typical sugarcanes grown from single plant cultures of different varieties grown in the Province. This woody matter technically known as ' fibre " is of great importance in the consideration of the milling properties of the cane. Some very interesting results have been obtained in these investigations which he hopes to publish fully. Mr. Taylor has also carried out a series of experiments on the influence of various manurial treatments on the time of ripening of the sugarcane under Indian conditions. It has long been known that heavy applications of manure tend to retard the ripening of sugarcane as well as of other crops. The climate of this Province, however, is so different to that of the countries in which work had been done on the subject that it was thought of interest to carry out a series of experiments to determine how far the effect of the manures was modified by the climate of Bihar. This series of experiments is being carried on and some results have already been obtained.

Another series of experiments has been commenced by Mr. Taylor this year to determine the effect of the time of planting of sugarcane upon the time of its maturity. Plantings have been made monthly from the middle of November until middle of March and observations on the state of maturity will be made during the current year.

UNITED PROVINCES.

The following action was taken on the lines recommended at the meeting of the Board of Agriculture in December 1911 in connection with the Sugar Industry.

The Government of India having accepted the recommendations of the Board of Agriculture, expressed in Resolution 8, appointed a Sugar Engineer and stationed him in the United Provinces. Mr. Hulme has had two short periods of working in the country, the last season being unfortunately curtailed by an attack of enteric fever. He has been principally engaged in assisting in the working of the aided factory at Pilibhit, a small factory in the Gorakhpur district, and examining into questions connected with the introduction of small plant for sugar making in the Provinces. He has also advised with regard to projects for starting new factories. His term of engagement will expire in 1914, but if work is to be of any permanent value, the engagement should be renewed for a longer term. It is understood that his services will also be required in the Punjab during the ensuing season.

Resolution 14.—The Local Government has granted a subsidy on certain terms to a sugar factory in Pilibhit and has also sanctioned advances for the construction of two factories in the Gorakhpur district, one of which is in course of erection. The Pilibhit factory had been put up some years ago by an Indian gentleman, but, owing to the faulty arrangement of the machinery and inexperience of the engineers employed, heavy losses had been sustained from breakdowns during the working season. Under Mr. Hulme's direction the factory had a prosperous season last year; and this success has done much to dissipate the idea which had become current in the provinces that such enterprises could not be profitably undertaken by Indian capital. The association of the department with the management of the factory is useful as it has permitted the investigation of the working qualities of the commoner canes of the district under manufacture, which has led to the elimination of a certain number from cultivation in the villages supplying the factory on account of impurity or excess of fibre. It has also enabled Mr. Hulme to study certain questions vitally affecting the future of the industry, such as the production of a sugar sufficiently closely resembling that made by indigenous methods to command a higher price; and also to study the most suitable machinery and processes for dealing with the cane-grown matters in which Mr Hulme believes considerable improvement might be effected. The experience gained has also served to refute certain dogmatically stated assertions regarding the impracticability of successfully running factories of any size in dependence on small growers—the difficulty being throughout to cope with supplies sent in. This and work of the same nature renders it additionally desirable that Mr. Hulme's services should be retained for a further period.

Resolutions 9 and 11.—An agricultural station has been opened at Nawabganj in the Bareilly district, which will be mainly devoted to sugarcane growing. In addition to the above, as the Partabgarh Farm, in which Mr. Clarke's work had hitherto been mainly carried, was unsuitable to the purpose, a small farm has been opened at Shahjahanpur in the heart of the sugarcane growing tract, to permit of his investigations as to the sugar constituents of the provincial canes, together with cultural experiments, being carried out under more favourable and representative conditions.

General.—The improvement in the methods of sugar manufacture undoubtedly continues to be the most immediately pressing problem in the United Provinces. The cultivation of cane is extending, and the area in 1912 rose by 6·2 per cent. to 1,424,338 acres. This year promises to show a further extension, possibly at the expense of poppy. The increase is mainly in the districts expotring *gur* to the Punjab and Rajputana. In the south-eastern districts such as Gorakhpur, which are unfavourably situated for this export trade, there has been a decline in cultivation, following on over-production and the very poor prices of the previous year. In 1912 when there was a very fine harvest some of the cane was fed to the cattle as, at the current prices of *gur*, it did not pay to manufacture it. From parts of this district cane is exported long distances to the Behar factories, where it must arrive in a very stale condition. *It is in such tracts that the need for factories equipped with modern machinery to utilise the* available material is most felt.

There has been some revival in the sugar-making industry from *gur* or *rab* owing to abundant harvests and better prices of sugar. The low prices of *gur* have led to the re-opening of two *gur* refineries which had been closed down; and the number of small factories working *rab* has increased. On account of the rising price of labour, there is an increasing tendency among the latter to employ centrifugalling machinery for separation of molasses. Up to this point the process of manufacture followed is identical with the indigenous process and percentage of sugar extracted to weight of cane no greater. As the average may be taken as about 3·33, as compared with 7¼ per cent. at Pilibhit, there is obviously an enormous waste of material. These small factories and the *gur* refineries can, therefore, only flourish on low prices for *gur*—that is at the expense of the cultivator. The fact of their existence, however, points to there being openings for factories run on sounder lines.

The reluctance of Indian capital to embark on the sugar manufacture, though primarily due to other causes, is to some extent fostered by misconceived ideas which have found currency about the unsuitability of the canes of Upper India for sugar manufacturing purposes. These will not bear critical analysis. In the best tracts of the United Provinces the tonnage averages over 20 tons per acre; while the average sugar content of the canes used at the Pilibhit factory was 15·47 per cent. and the purity of the mill juice averaging 82·50. The year was a particularly good one and such figures are not likely to be regularly maintained; though the manufacturer could do much by eliminating the inferior canes grown by the cultivators supplying his factory. They serve, however, to show that the inferiority of the canes is not so marked as to preclude the possibility of successful competition with other countries.

Though little definite progress can be recorded in the establishment of central factories, the matter has excited a certain amount of interest and several projects have been mooted which may eventually take some practical form. Without Mr. Hulme's assistance it is unlikely that these projects will come to anything, in view of the great difficulty of obtaining expert advice and the reluctance to bring out Europeans. The retention of his services would, therefore, be the most practical method of furthering these and similar projects.

PUNJAB.

Agricultural.

1. The *agricultural* work which has been done will appear from the following note by Mr. Southern, the Deputy Director in charge of the Gurdaspur farm.

Description of the Gurdaspur farm.

"The farm is situated in the middle of the cane-growing tract, and is divided up into two blocks of 50 acres each. The one-block is rain-fed land and here wheat cultivation is forming the subject of investigation. The other block is irrigated from a tube well and a commencement has here been made with the study of the sugar-cane crop.

"The farm land was acquired in 1911 but, as much of the area was under trees, little work was possible in the first year apart from the clearing, levelling and ploughing of the land. In the kharif of 1912 the whole area was brought under the plough, but the land is still far from uniform. No permanent experiments have yet been laid down, but this, it is hoped to do in the coming year.

Object aimed at.

"The object being aimed at at Gurdaspur is the production of a cane of better quality and higher yielding powers than the cane at present grown. The variety also must be one that will stand up well and resist frost. The work up to date, outlined as recommended by the sub-committee and endorsed by the last board, has been as follows.

(a) The survey and testing of local varieties.

"A collection of Punjab canes from all over the province was made in 1911 and these varieties have been grown side by side on the farm since then. One or two additions have been made, and the collection is probably now complete. The testing of the varieties is under chemical control.

"Surveys of the Gurdaspur and Hoshiarpur districts have been made, while an analytical survey is also being carried out by the Agricultural Chemist in the Gurdaspur district. Dr. Barber visited Gurdaspur during the sugar-cane season of 1912 when he made a study of local conditions and requirements. Varieties of Punjab canes were then sent to Madras, and are now under observation on the breeding station.

(b) The testing of imported varieties.

"Varieties were imported from the United Provinces, Central Provinces, Bengal and Madras in 1911 and are being grown side by side with local varieties. Many of the imported varieties, especially the thick canes, are proving quite unsuited to the Punjab climate and such are being gradually eliminated.

"The most promising of the imported varieties are under chemical control.

(c) Distribution of varieties.
(d) Demonstration of improved mechanical methods.

"Nothing has so far been done under these two heads.

(e) (1) Tillage.

"There is little doubt that deeper cultivation will prove economically sound in the preparation of sugarcane land. In the past year the highest yields have been obtained where the deepest cultivation was given. Another point

which is receiving attention is the after-cultivation of the crop. The importance of this is generally recognised, but the great expense of hand hoeing and weeding does not allow of it being done as often as is desirable. Bullock implements are being experimented with for the purpose and for shallow surface cultivation peg toothed harrows have proved effective. An implement is, however, wanted which will stir the soil more deeply in the neighbourhood of the sets without bringing them up to the surface. A cut-away disc harrow has been tried for the purpose, but without success: probably some implements on the lines of a sub-soiler will prove more suitable.

(e) (2) Drainage.

"The natural drainage throughout the tract is good, but after the monsoon breaks in July rain often falls more or less continuously for a month or six weeks when water lies in the fields. During this period artificial drainage would probably prove beneficial. The growing of cane on ridges is accordingly this year being tried. This is being done however more especially with a view to studying the effect of drainage on the ripening of the cane.

(e) (3) Manuring.

"Manurial experiments will be commenced this year now that the testing of the land has been carried out. It is the practice amongst the best cultivators not to manure the cane crop directly, but to apply the manure to the previous crop, which is usually maize. By applying manure directly to the cane crop there is a danger of the ripening being delayed and the quality of the *gur* spoilt.

(e) (4) Rotation.

"The following rotation, which is generally recognised as the best amongst zamindars, is being followed on the farm:—

1st year.—Maize.

Catch crop of *senji* (*melilotus parviflora*).

2nd year.—Sugarcane.

3rd year.—Wheat.

Conclusion.

"I have purposely made no mention of yields as in the first year (1911) the varieties were grown on very small areas for propagation only, while last year the land proved so variable that a comparison of yields would be valueless."

Chemical.

2. Mr. Barnes has carried out a large number of *chemical* analyses of the canes of the Gurdaspur district, which have been recorded in separate printed notes.

Pioneer factories.

3. The only pioneer sugar factory in the Punjab is the Harkishen Sugar Mill in Amritsar owned by Raja Ganesh Das, where refined sugar is made by modern processes from thick cane (ponda) and also from *gur*. The capacity of the crushing mill is 100 maunds of ponda cane or 70 maunds of thin cane per hour. Working with *gur* 162 maunds are used daily. The *gur* is obtained from Gorakhpur in the United Provinces as it is better, and, even with the addition of freight charges, cheaper than local *gur*. There has not been very constant work on cane as the owner of the factory has not hitherto grown much cane of his own, and the local price, which rises to about Rs. 800 an acre equivalent to Re. 1 a maund of cane, is prohibitive. From *gur* about 46 per cent. of sugar is now obtained. Mr. Barnes has thoroughly inspected and reported on this factory and carried through a series of analyses. He finds the loss of sucrose to be considerable, and puts it down largely to the method of lime defecation used which causes the formation of a tribasic saccharate of lime. I have recommended to government the grant of Rs. 20,000 to this factory on the following conditions:—

(1) That in each of the next three years 80 acres of thick cane will be grown by the factory with the assistance of the agricultural department on land taken on lease.

(2) That the owner will introduce the double carbonation process for the clarification of juice to the satisfaction of the Agricultural Chemist.

(3) That he will obtain the assistance of a competent chemist if there is one to be had in Amritsar.

(4) That he will allow the factory to be used for demonstrations of sugar manufacture.

(5) That he will allow the factory to be used as a training place for sugar engineers and boilers.

Orders have not yet been passed.*

Gur making and increase of area under cane.

4. Proposals for the establishment of a co-operative society of cane growers for the centralized manufacture of *gur are under the consideration of government. The society* would be formed in the Gurdaspur district which is the best sugar tract in the province. The crushing plant would deal with 40 or 50 tons of cane in a 22-hour day which could be obtained within a radius of 3 or 4 miles from the factory. Only open pan boiling would be used at first. By centralizing manufacture, each individual cane grower would be saved from the troublesome manufacturing processes and enabled to grow a much larger area of cane. The capital required would be about Rs. 30,000 which would be raised by shares carrying a fixed rate of interest. I have proposed that Government should assist by taking Rs. 10,000 worth of shares. The success of the factory will depend on the price which the co-operators will be content to take for their cane. With *gur* at Rs. 3-8-0 a maund they calculate that they obtain at present $5\frac{3}{4}$ annas per maund of cane, but the factory will pay only if cane can be bought at $3\frac{1}{2}$ annas a maund.

Extension of sugar area and central factory.

5. In order to make the establishment of a central sugar factory possible, I have proposed that on the government waste lands to be irrigated from the Lower Bari Doab Canal a block of 50,000 acres favourably situated as to irrigation facilities and means of communication should be marked off as available for cane growing for one or more central factories. The land would be allotted to cultivators—whether peasants or capitalists—like any other land, but subject to the following conditions:—

(1) *That if a factory approved by Government is established, not less than $\frac{1}{5}$th of each holding shall be placed* under cane every year.

(2) That the cane shall not be sold for the manufacture of white or crystallized sugar except to the factory.

(3) That the price to be paid for the cane shall be fixed annually by agreement between the growers and the factory owners.

In this way 10,000 acres of cane would be grown annually within an area of 78 square miles, and this would be enough to supply one large or several small central factories. The factory owners would through the prohibition *of outside sale be secured from competition by other sugar-makers, while the growers by the reservation to them of* power to manufacture *gur* from their cane would be able to insist on as good a return to themselves as they could obtain from making *gur*. I do not think we should go further in limiting the price which the owners may ask.

The Financial Commissioners have accepted this proposal.

The weak part of the proposal is that in the tract, where the land is to be reserved, the rainfall is so small that the conditions are not the best for sugarcane growing.

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* Government has refused the grant until the improvements recommended by Mr. Barnes are introduced and the factory is financially sound.

BOMBAY.

Crusher.—Comparative tests have been made with the horizontal roller mill known as the Pearl by G. S. Squeres & Co. of Buffalo N. Y., the Nahan mill by the Nahan Foundry, and the Punjab and the Poona mills made locally.

These tests demonstrated that working under usual conditions the Pearl gave an extraction of 5 per cent. higher on the cane than the other two which were nearly equal. In capacity the Pearl mill crushes 50 per cent. more cane with the same bullock power than the Poona mill or Nahan mill. One less labourer is required to operate it. Its price is Rs. 350. The Nahan mill is for one pair of bullocks and its capacity is only ⅔rds of that of the Poona. The comparative working of these mills was demonstrated before a deputation of cultivators from four Deccan Districts and orders were received for Pearl Mills which have since been filled.

Furnaces.—The new types of double and multiple furnaces have been devised during the last two years at Manjri whereby, through saving of the waste heat, the fuel required to boil a given quantity of juice has been reduced by 40 per cent. over that required by the Poona type; which itself was an improvement of 25 per cent. over the still older type. Even further improvement is expected. This furnace not only saves fuel but saves an hour's time with each pan, reduces the labour by 60 per cent. over the Poona furnace and improves the quality of the gul due to better clarification and more careful boiling.

Cane varieties.—Two Mauritius canes were imported several years ago by J. Mollison, Esquire, and two years ago a small quantity of eight varieties was brought from Samalkota including Mauritius, Java, and Barbadoes seedlings. These are being increased sufficient for experiments and to these have been added the Kaberia of Sholapur, the Wansia of Gujarat and the Sanbile of the Southern Maratha Country.

A beginning was made in selection through testing the specific gravity of canes of Pundia variety by the method advocated by Maxwell of Mauritius and results will be expected in January. A considerable number of Pundia sets have been distributed in Gujarat and Satara.

Tillage Experiments.—Our tillage experiments include cheaper methods of preparing the land, rotation, kind of sets and method of planting.

The Eagle Gallows plough by Ransomes Sims & Jefferies, the Disc Harrow, an efficient cultivator and digging machine when utilized in preparing land for cane, result in a total saving of nearly 50 per cent. of the cost.

The rotation experiment has demonstrated that san as a green manure crop can be depended upon to furnish the organic manure and is more profitable than fallowing or taking a fodder crop. In the new series the rotation has been made to include ground-nut. The work with sets has proved that plant cane furnishes better sets than ratoons, that sets from terminal parts of the cane when used produce a better crop, and as they contain less sugar they do not lessen our out-put of gul as much as the use of the older parts of the cane do.

When some care is exercised in assorting the sets so as to exclude small broken or dry pieces the resulting crop is benefitted as is shown by an increased yield of 10 per cent.

Thick planting in the row with a distance of four feet between rows results in a great saving of labour. This was tried only this year and the crop is not yet harvested; so out-turn figures are not available.

Manurial Experiments.—The most striking manurial results of the year have been the demonstration of the great value of trash as a coarse manure to the soils about Poona. The new furnaces make it possible to utilize nearly ⅓ths of the trash for this purpose and it seems to be more valuable than farmyard manure pound for pound, its effects being marked even in the succeeding ratoon.

Sulphate of Ammonia continues to be the most profitable source of nitrogen to supplement bulky manures.

Considerable time has been spent in studying the factors which influence the quality of gul and we note that ripeness, clarification, time occupied during the last stages of boiling, temperature of striking and agitation during cooling, play more important parts than soil, climate or manure.

A Summary of other important work on Sugarcane since 1911.

A survey of red rot disease (due to the fungus Colletotrichum falcatum) was commenced in 1910 in this Presidency. The districts that were surveyed were Surat, Poona, Satara, Khandesh, Sholapur and Dharwar. The disease was found to be doing considerable damage in Surat and Satara Districts, and it was thought desirable to take immediate steps to check it. Accordingly disease-free canes from Poona were distributed among selected cultivators at Amalsad in Surat District and at Yellur in Satara District. Since then the distribution work has been continued in Surat District only. Now there has been a sufficiently wide distribution of the disease-free stock and from next year it is intended to stop the distribution work. Further work will mainly consist of advising the people about selection of sets. Survey of the other parts of the Presidency will be continued. Recently there has been much work done with regard to the parasitology of this red rot fungus and West Indian Mycologists seem to think that the behaviour of the fungus in the West Indies is different to that of the organism in the Eastern Tropics. The spread of the fungus seems to depend not only on diseased cuttings but also on a good many other conditions, *viz.*, water stagnation, drought, variety of cane, its age and also the borer insect. The question, how far it is safe to plant healthy cane in a recently affected field is also not solved as yet. Next year experiments involving all these problems will be undertaken.

MADRAS.

Work on the Sugarcane station, Coimbatore.

At the last meeting of the Board of Agriculture, 1911, it was considered doubtful whether cane seedlings could be successfully raised in India, previous trials having generally resulted in total failure.

The question was taken up at Coimbatore by the Government Botanist during the Christmas holidays immediately succeeding the Board's meeting, but it was found that most of the canes had ceased to flower. Some, however, put out a few arrows and these were sown in pots on the chance of their providing seedlings. The sowing was done in various different ways, most of which have since proved to be unsuitable. Many of what were considered "successes" turned out to be grass seedlings but a few which turned out to be true canes were obtained from four of our local varieties. The matter was finally set at rest by some arrows of *Cheni* received from Dr. Coleman in April, these giving quite a number of seedlings, and it was discovered that the opening of the anthers was the factor which determined the formation of seed. The cane arrows in North India only produce ill-formed closed anthers with no fertile pollen while many in South India are found to have well formed anthers which split readily and contain varying quantities of healthy pollen. A summary of the work at this stage was published in the Agricultural Journal.

The seedlings obtained were grown with great care in the Coimbatore Botanic Garden; at the same time a collection of Indian canes was started and these also were planted in the Botanic Garden, although in less suitable land.

The appointment of Sugarcane Expert was made on October 25th, 1912, and more rapid progress was made. A close study of the morphological characters of the different canes collected was commenced and special attention was paid to the anthesis of the local canes which were beginning to arrow. An effort was made to obtain as many seedlings from as many different parents as possible. Although it was a poor arrowing season, working with the experience gained in the previous year, we succeeded in getting a very large number of seedlings (12,000—15,000).

Of these a few were obtained from arrows of canes growing in the Botanic Garden, but the great bulk were derived from South Indian canes grown in the fields round Coimbatore. In these circumstances little control could be exercised over the exact parentage. About 70 seedlings were obtained from selfing arrows of Saretha and a number of crosses between Saccharum spontaneum and *Chin* and *Shakarchynia*, but in the greater number of seedlings the mother alone is certainly known.

Pending the acquisition of the land for a cane-breeding station, two long tours were made in North India, where the agricultural conditions were studied and many varieties of cane were collected and forwarded to Coimbatore. A detailed study of the morphological characters of these was made where possible with the object of determining their relationship to one another and their value as parents of possible seedlings. It was considered that the Desi canes of India would be more likely to produce healthy and hardy offspring than the better class canes which had from time to time been introduced into the country. Special attention has therefore thus far been directed to the indigenous canes. A further "rains" tour is in progress as this note is being written and, by the time the Board meets at Coimbatore it is hoped that all sugarcane tracts of India will have been visited excepting Burma and Assam.

The farm land was acquired on the last day of the official year, March 30, 1913. A selection of the strongest of the seedlings was made and over 2,000 were planted out and are growing well at the time of writing. The varieties were also planted out but in a less favourable position. Owing to the delay in the installation of the engine and pump, many of these varieties suffered severely because it was necessary to irrigate them with very alkaline water. The farm land is of the "dry" and "garden" type, it being considered more in keeping with the North Indian cultivation to grow the canes on this land than on the "wet" land usually employed. As however the farm land has never grown sugarcane before it will take some time before it is brought into proper condition for growing cane crops; the land for next year's plots is therefore receiving special attention.

The laboratory and farm buildings have been completed and the oil-engine and pump are working satisfactorily. A good road has been made connecting the cane-breeding station with the central farm so as to render it easily accessible.

Last year's seedlings have been reaped, analysed, exhaustively studied and replanted. Nothing very definite can be said as to the quality of the seedlings because the ground on which they were grown in the Botanic Garden was unsuitable, but in one at least the two main qualities desired, vigour and richness of juice, are united. The study and analysis of the large number of seedlings now growing will be difficult and the chemical part will be quite beyond the process of the single chemical assistant. It is hoped that some arrangement may be made by which chemical assistants can be borrowed from other sections for the two months or so during which the crop will be reaped. For various reasons it is considered desirable, at any rate at present, to analyse all the selected seedlings.

CENTRAL PROVINCES.

The Central Provinces are not yet of importance as a sugar-producing area, and the operations of the Agricultural Department are still concerned rather with the cultivation of cane than with industrial problems connected with its products. The area under sugar-cane is still much smaller than was the case 25 years ago, but the Government irrigation schemes already completed or in progress open a wide field for development of this branch of agriculture. The experimental cultivation of sugar-cane is therefore one of the main objects of the Tharsa Farm in the Nagpur District, recently opened in the area commanded by the Ramtek tank, and of the Sindewahi Farm, recently opened below the Garmusi tank in Chanda, which has been acquired from a private proprietor. In addition to these two farms, cane is also cultivated under the supervision of the Department below some Government tanks in the Raipur, Chanda and Bhandara Districts. Progress is slow but steady, and the areas thus put under cane have risen during the last two years from 116 to 429 acres, which lie in 154 villages. These villages are all in the Wainganga Valley, but the tract which probably has most promise for the future is the plain of Chhattisgarh in the east of the Province. Here cane is privately cultivated, under the supervision of the Department, below some Government tanks, but a more certain source of constant irrigation is needed, and this will be supplied on completion of the Mahanadi and Tandula canal schemes. It is with the utilization of these schemes in view that cane cultivation has been started by the Department in Chhattisgarh. In the north of the Provinces there is also some scope for the extension of cane under the small irrigation tanks constructed in that tract, and its experimental cultivation has therefore been started at the Adhartal Farm near Jubbulpore, which was opened 18 months ago. It will thus be seen that the cultivation of cane has a prominent position in all the most recent operations of the Department.

2. *Experiments.*—The two chief experimental stations are the Tharsa and Sindewahi Farms, both of which have been opened within the last two years. The Tharsa Farm is composed of black soil of somewhat inferior quality, while the Sindewahi Farm includes an area of a light porous loam, locally known as *wardi*, excellently adapted to cane-cultivation. In addition, the Telinkheri Farm near Nagpur gives an opportunity of growing cane under the close and constant supervision of the Deputy Director of Agriculture, aided by the Economic Botanist and Agricultural Chemist.

3. A large variety of canes has been grown at all these farms. At Tharsa the heaviest yielder of cane has been found to be "Sunnabille," a thin hard variety, the seed of which was originally obtained from Bombay, and it is this variety that is mostly supplied and recommended to cultivators of the neighbouring tract. It has this year yielded 43·1 tons of unstriped and 35·3 tons of striped cane per acre, results which are very satisfactory, considering that the soil is of somewhat poor quality and that the plots had not been manured at the time of planting in the newly opened farm. The highest yielder of *gur* (4·02 tons per acre) proved to be "Pundia," a thick variety, also obtained originally from Bombay, but this cane is very liable to red-rot and cannot therefore be generally recommended to cultivators. Second as a *gur*-producer stands "Lenji," a high quality soft cane of medium thickness. Of the thick canes the most promising, both at Tharsa and Sindewahi, appear to be "Striped" and "Ashy" Mauritius. The thick varieties were damaged to some extent by stem-borer, "Red Mauritius" suffering especially from this pest. Attempts are made to check its inroads by sowing maize as a trap-crop round the cane, but it has been found that the pest is harboured in the stubble of juar. The only remedy here is for cultivators to uproot and destroy the stubble, a somewhat laborious and unwelcome task if the cultivator is not himself a cane-grower. At Sindewahi the local "Katai" variety, a very poor thin reed-like cane, was found to be much affected by red-rot, and it will be matter for congratulation from every point of view if this local variety is ousted by some better kind.

4. The manurial experiments have not yet been tried long enough to publish any conclusions. But it is of interest to note that *til*-cake as a manure has been successfully introduced to cultivators by the Department. The use of cake-manure for cane has been unknown up to the present in these Provinces: supplies are obtained from the Raipur oil-mill, which has hitherto had some difficulty in disposing of the oil-cake locally.

5. If central sugar factories are to be established, it is of importance that the supply of cane should be extended over as long a period as possible instead of all the cane coming to hand at one and the same time. To this end experiments are being tried to ascertain the degree of success that can be obtained by planting from October onwards to March. As far as the experiments have gone they show that even the cane planted as early as October gives better results than that planted, according to the common local practice, towards the end of the cold weather. The cane establishes itself well at this early season, and can withstand the mild winter conditions which prevail in the south of the Provinces.

6. Another experiment in course of trial has for its object to see how far the cultivator can economize by using only the top-shoots of the cane for planting. In the case of the thin variety "Sunnabille" the top-shoot sets

germinated better and gave a larger yield than sets taken from the whole cane. "Red Mauritius" top-shoots were, however, badly affected by steam-borer.

7. Experiments in different methods of cultivation have been made to compare the ridge-and-furrow system, as practised locally, with the Madras bed-and-furrow and the Java drainage system. It is too early to publish definite conclusions, but the Madras system appears to result in a considerable saving of time and labour.

8. *Chemical analysis.*—Ten varieties of cane grown at Tharsa and 34 varieties grown at Telinkheri were subjected to analysis by the Agricultural Chemist at fortnightly intervals during the ripening season. The composition of the juice on those days when each variety showed its maximum amount of sucrose is shown in the table appended to this note.

9. *Demonstration and aid to cultivators.*—The areas devoted to cane by cultivators, under the advice and supervision of the Department, have already been mentioned. Seed is supplied from the Government farms, the number of canes distributed last year for this purpose being 71,000 from Tharsa, 38,000 from Sindewahi and 35,000 from Raipur. At Sindewahi, where the demand far exceeds the supply, 20 acres of cane will be mostly devoted to this purpose, and to the supply of Mr. McGlashan's enterprise mentioned below. Takavi loans are also readily available to cultivators. The advantages of cake-manure have been brought to their notice, and approximately 200 tons of this manure were supplied to them during the past year. The Poona furnace and system of *gur*-making were demonstrated at 21 centres in the Nagpur Division; there is now also a good demand for improved iron crushing mills. In one tract of the Jubbulpore District these mills have now entirely ousted the old-fashioned local mills. Experiments have shown that the Nahan mill, costing Rs. 130, expresses from 70 to 73 per cent. of the juice in the case of thick and 63 to 66 per cent. in the case of thin cane. Messrs. Burn & Co.'s mill which cost little more than half the price of the Nahan mill, expresses about three per cent. less. Both mills find favour with cane-growers.

10. *Factories.*—An option for a sugar-cane factory area, commanded by the Ghorajheri tank, has been granted by the Local Administration to Mr. J. McGlashan of Cawnpore, with a view to the formation of a company. A lease, has been drawn up of 4,632 acres of Government waste land untrammelled by any rights or obligations of tenants, and clearing operations are in progress.

Table showing the composition of the cane juice obtained on the days when each cane showed its maximum amount of sucrose on the Experimental Farm, Tharsa.

Variety.	Date of planting.	Date of crushing.	Percentage of juice in cane.	Corrected degree brix.	Percentage of sucrose.	Percentage of glucose.
Pounda	15th February 1912	18th March 1913	66·8	20·1	18·81	·53
Pundia	15th " "	Ditto	69·9	17·6	15·24	1·59
Sunnabille	15th " "	3rd March 1913	66·8	18·1	16·36	·53
Lanji	20th " "	15th February 1913	74·5	19·1	17·73	·25
Red Mauritius	15th " "	18th March 1913	66·4	17·5	15·19	1·32
Ashy Mauritius	16th " "	15th January 1913	65·8	17·7	15·81	1·15
Pachranga	17th " "	1st March 1913	71·3	17·6	15·86	·99
Kala	17th " "	Ditto	70·3	18·6	17·10	·75
Khari	15th " "	15th February 1913	65·5	17·8	16·17	·36
Striped Mauritius	16th " "	15th January 1913	65·7	19·4	17·76	·67

Chemical analysis of the juices of 34 varieties of cane on Telenkheri Seed Farm.

No.	Variety.	Date of cutting.	Corrected degree brix.	Percentage sucrose.	Co-efficient of purity.	REMARKS.
1	B. 1529	20th January 1913	20·5	19·12	94·1	Analyses done twice.
2	B. 376	21st January 1913	18·5	16·85	92·0	Do.
3	B. 147	Ditto	18·2	16·57	92·2	Do.
4	Java seed 36	Ditto	18·5	16·03	87·4	Do.
5	Villia	Ditto	16·8	14·01	84·3	Do.
6	B. 1753	Ditto	16·3	13·99	87·0	Do.
7	Java seed 247	Ditto	17·7	15·45	88·7	Do.
8	Redspot	Ditto	19·0	17·34	92·7	Do.
9	Khari	Ditto	16·0	13·82	83·6	Do.
10	Tana striped ordinary	29th January 1913	16·7	13·98	85·9	Do.
11	Green Tana	Ditto	17·0	[illegible]	86·7	Do.
12	Phear's green pounda	30th January 1913	15·7	13·39	87·0	Do.
13	Striped Mauritius	Ditto	19·0	17·32	93·1	Do.
14	Red Mauritius	Ditto	18·0	15·42	87·5	Do.
15	Pundia	Ditto	18·4	15·94	88·3	Do.
16	Red Mauritius with black stripes.	Ditto	16·7	13·19	81·0	Do.
17	Pounda	Ditto	18·3	16·03	89·4	Do.
18	Ashy Mauritius	31st January 1913.	18·1	15·55	87·6	Do.
19	B. 208	Ditto	19·5	17·84	92·4	Do.
20	Gilmaries redspot	Ditto	19·6	17·72	91·8	Do.
21	Langi	Ditto	18·6	16·81	91·8	Do.

Chemical analysis of the juices of 34 varieties of cane on Telenkheri Seed Farm—contd.

No.	Variety.	Date of cutting.	Corrected degree brix.	Percentage Sucrose.	Co-efficient of purity.	REMARKS.
22	*Sunnabille*	*31st January 1913*	17·2	14·55	85·6	Analyses done twice.
23	Redspot	Ditto	16·9	14·01	84·8	Do.
24	Bangla	4th February 1913	18·6	16·25	89·5	Do.
25	Bansi	Ditto	19·3	17·54	93·3	Do.
26	Striped Chanda	Ditto	17·9	14·25	82·5	Do.
27	Kala Chanda	Ditto	16·2	12·13	77·0	Do.
28	Kalvi	Ditto	15·0	11·18	77·2	Do.
29	Green Mauritius	3rd January 1913	14·5	10·17	71·8	Analysis done only once.
30	Bilaspur pounda	20th January 1913	16·6	14·28	87·2	Do.
31	Kagli	Ditto	18·6	16·11	87·5	Do.
32	Green pounda	29th January 1913	18·8	16·26	88·5	Do.
33	Shamsara	Ditto	18·0	15·10	85·8	Do.
34	Yuva	Ditto	16·4	13·01	81·2	Do.

ASSAM.

The work of testing indigenous and exotic varieties of cane under chemical control has been continued at Jorhat. As a result of the past five years' work, several exotic canes have been discovered to yield nearly 30 tons of cane per acre with juice containing from 16 per cent. to 18 per cent. of cane sugar and purity co-efficient of over 90. In 1912 one variety, *viz.*, B376 (1st ratoon), gave over 33 tons of cane per acre with juice containing 16.74 per cent. of cane sugar and purity co-efficient of 94. Another variety, B147, while yielding less cane per acre than B376, gave juice containing over 18 per cent. of cane sugar in both the plant and 1st ratoon crops.

Manurial cultivation and planting experiments are also in progress, but are not advanced sufficiently to enable us to draw definite conclusions.

2. The distribution of the two best varieties, *viz.*, B376 and B147, tested at Jorhat has been continued, and demonstrations have been made on cultivators' holdings in the district, with the result that this year we had more applications for cuttings of these two varieties than we were able to supply from our limited area.

3. With regard to the introduction of improved mechanical methods, the only progress we are able to report is in connection with the use of the 3-roller iron crushing mill instead of the old wooden mill, which is still used extensively in the remote villages of Upper Assam.

This year six iron roller mills were sent out in charge of demonstrators, with the result that several cultivators have ordered mills of this type. Next year we propose to extend these demonstrations.

4. The most important advance made during the last twelve months is in locating and surveying large areas of land in the district of Kamrup, which are apparently suitable for sugarcane cultivation on an extensive scale.

For this purpose the Deputy Director of Agriculture, accompanied by Mr. Phillip Johnson of Messrs. Fowler & Co., toured along the Bhutan frontier, where they discovered several large tracts of land, upwards of 10,000 acres in extent, which appeared eminently suitable for cultivation by steam tackle. As a result of a note submitted by the Deputy Director of Agriculture to the Agricultural Adviser to the Government of India, it is proposed to make an experiment in the cultivation of sugarcane by steam tackle on one of these large blocks of land. The experiment with steam tackle will probably not be commenced until the cold weather of 1914-15, but in the meantime we propose to put down about 40 acres of good varieties of cane in the spring of 1914 to provide cuttings for the larger experiment.

It is proposed, in the first instance, to open up as much land as can be dealt with by one double engine unit of steam tackle; this area will probably be from 800 to 1,000 acres.

If the experiment proves successful, it is open to capitalists to take over the whole concern at the end of two or three years, extend the area under cane, and build an up-to-date factory capable of dealing with the produce of from 3,000 to 5,000 acres of cane. If successful, this pioneer concern would form the nucleus of a larger industry in this province, as there is sufficient land of the same kind in Kamrup district alone to support some five or six large factories.

BURMA.

At the Board of Agriculture Conference held at Pusa in November 1911 it was resolved that in view of the decreasing area under sugar-cane in India, due to imports of white sugar from Java and other countries special attention should be paid to the crop by the Agricultural Department in the various Provinces.

Among other motions passed by the Board were the following:—

(1) "The Board recognizes the value of the action already taken by some Local Governments to reserve certain areas of suitable land for the establishment of central factories, and hopes that similar action may be taken, where possible, by other Local Governments, and that grants of available land may be made on favourable terms."

(2) "The Board recommends that Local Governments should be empowered to assist pioneer factories, by subsidy, by taking deferred shares, or by such other methods as may be appropriate and urges the need for a reconsideration of the recent orders of the Secretary of State, in so far as they prevent the application of public funds to the development of those industries which are essential to the increase of the wealth of the agricultural community."

In accordance with these motions the Agricultural Department in each province was asked to report on areas of not less than 10,000 acres each, suitable for sugarcane growing and the creation of a white sugar factory and to report the progress made in the matter at the next Board of Agriculture Meeting, *viz.*, that to be held at Coimbatore in February of next year.

Attention was drawn at the Conference to the large area of undeveloped waste land in the Tenasserim Division and the desirability of holding special investigations as to the possibility of introducing sugarcane cultivation on the factory system in this part of the province, was pressed upon the representative of this Department. Since the Conference was held, a sugar expert from Java acting on behalf of a Rangoon firm has been touring in Burma with a view to the establishment of a factory. This expert has pointed out that the existence of adequate irrigation facilities is an essential preliminary for the successful working of a central factory of sugarcane and has expressed the opinion that the only suitable locality is the area commanded by the recently opened Môn Canals in the Minbu District of Upper Burma.

The possibility of starting a factory in Tenasserim has nevertheless been considered by the Department. It is however found that in Tavoy facilities for irrigation are absent and that all the suitable land has been already occupied.

In Mergui, irrigation on an adequate scale might be obtainable in parts, but the complete absence of roads, or railways together with the remoteness of the areas where alone the irrigation is likely to be obtainable places in the opinion of the Department, any attempt at sugarcane cultivation on a capitalist scale outside the scope of practical politics. When the country is opened up and communications have come into existence it will be possible to reconsider the question.

The Department agrees with the sugar expert already referred to that the Môn Canals area appears to be the most likely spot for the establishment of a sugar factory. The lack of communications and the fact that here also the land is largely in private hands have hitherto prevented the successful initiation of the scheme which it is understood the Rangoon firm in question desires to carry out.

With the intention of assisting in the development of sugarcane cultivation in this area the Department has opened a small experimental station at which special attention will be given to this crop.

NORTH-WEST FRONTIER PROVINCE.

Refined sugar.

A sugar refinery which was started in Peshawar in the year 1910 ceased work after treating the 1912 crop. The chief reasons why the concern failed are :—

1. The refinery was in charge of men who had no proper experience of sugar refining.
2. The refinery was unfavourabley situated.
3. Sugar-cane in Peshawar ripens in late November and while frost and cold winds prevail, between 15th December and 1st February.
4. Peshawar "Gur" commands a high price in the markets of Northern India.

It is possible that thin "ukh" cane might withstand the severe weather of the frontier better than the thick "paunda" cane which is cultivated in the Peshawar valley, but it is at the same time sufficiently profitable to grow the higher quality cane for the production of "gur."

Gur.

On extensive field areas, "Peshawari" White Paunda cane has proved more suitable for the production of "gur" than Striped, Red, or Ashy varieties of cane from Mauritius.

Agricultural aspect.

At the Peshawar Agricultural Station, where irrigation facilities are exceptionally favourable, the Kabul River Canal cannot be depended on to give regular and timely supplies of water to a block of 8 acres of "paunda" sugarcane, and zemindars in the North-West Frontier Province can rarely depend on irrigation for blocks of more than 2 acres of cane from any Government Canal. It has also been impossible to find farmyard manure for 8 acres of sugarcane and zemindars cannot treat more than 2 acres, even when the crop follows *shaftal* (*Trifolium resupinatum*). On account of the small size of the sugar-cane fields it does not appear that the present high cost of cane cultivation can be materially reduced.

Area for extension.

It is probable that the present area of 30,000 acres of sugar-cane in Peshawar District will greatly extend with the opening of the Upper Swat Canal.

Sugar-beet.

Sugar-beets were successfully grown on field areas in Peshawar in 1911-12 and 1912-13, and in a series of analyses which Dr. Leather conducted at Peshawar, he found that the sugar in the juice in roots taken at regular intervals over ½ of an acre was 15·62 per cent., and that some roots yielded as high as 20 per cent. sugar in juice.

It has been ascertained that :—

(1) the climate and soil of Peshawar are suitable for beets.

(2) the methods of cultivation practised by the North-West Frontier Province zemindars are adopted to beet growing.

(3) sugar-beets would give employment during the cold season, when the zemindars are not otherwise busy.

(4) sugar-beets ripen seeds in Peshawar within 10 months of the date of sowing the crop.

(5) when sugar-beets follow *shaftal* (*Trifolium resupinatum*), manure is not required for the crop on land of average quality.

Since the year 1909, chillies (Solanum Capsicastrum) have been seriously affected by a disease (*Colletorichum nigrum*) and the crop is gradually going out of cultivation in Peshawar valley. From some points of view sugar-beets might take the place of chillies in the frontier-mens scheme of cropping, but without a factory close at hand this is doubtful.

APPENDIX—C.

(2)

Subject VII:—Sugar beet cultivation at Peshawar.

(MESSRS. J. W. LEATHER AND W. ROBERTSON BROWN.)

The attention of one of us was directed some two years ago to the possibility of growing sugar beets in the Peshawar District. Culinary beet root is grown in this district as a garden crop, and is to be had for some nine months in the year, which fact indicated that the sugar beet might also be successful. If this were so, the potentiality of a beet sugar industry would be indicated. For its success the following conditions must be satisfied:—

(a) An assured supply of suitable sugar beets over a period of at least four months.

(b) The presence of a well managed factory.

(c) The cost of growing the roots, haulage and subsequent manufacture must be sufficiently moderate to yield a paying profit.

It was evident that before either the capitalist or the Zamindar could properly be approached with recommendations, the possibility of a suitable supply of roots must be tested.

Accordingly in 1911, a number of varieties of sugar beet were grown. Specimens of these were subsequently analysed at Pusa, and some were found to be of high quality. Thus:—

		Per cent. of Sucrose.
March 1912	Vilmorin varieties	11-12
April 1912	Several other varieties	3-10
June 1912	Vilmorin varieties	17-20

Having obtained this information regarding quality, two half acre plots were sown with Vilmorin's Selection B in October and November 1912 respectively. In order to obtain analyses of the fresh roots, apparatus was taken to Peshawar and the analyses made there early in May 1913, which avoided the risk of changes occurring in the sugars during the long railway journey to Pusa. Twenty individual roots were tested from the two plots, and these were found to contain from 10 per cent. to 18 per cent. sucrose, and from ·05 per cent. to ·10 per cent. invert sugar on the October sown plot: whilst for the roots from the November sown plot the corresponding figures were 10 per cent. to 17 per cent. sucrose, ·01 to ·10 invert sugar. For more complete details reference may be made to the *Annual Report of the Peshawar Agricultural Station for 1912-13.*

Whilst the examination of the individual roots was desirable in order to form an idea of the amount of variation that existed, samples were taken from the two plots in order to ascertain the average or mean quality. The following shows the results of these analyses:—

When sown.	Average weight per root.	Juice.	Fibre.	Juice: Sp. gravity.	Juice: Sucrose per cent.	Juice: Invert sugar.	Sucrose per cent. in root.
October (i)	1·67	93·25	6·75	1·069	15·76	·08	14·68
October (ii)	1·57	92·84	7·16	1·068	15·84	·07	14·73
November	1·28	93·33	6·67	1·067	15·26	·07	14·25

The average quality, namely 14½ per cent. sucrose per 100 parts of root together with a low proportion of invert sugar is a good percentage even from an European standpoint, and considerably better than what was obtained in California when the industry was first started there.

Co-efficient of purity.—This varied in the Tarnab roots from 85 to 90 per cent. which is higher than the German average. Thus so far as quality is concerned, it is demonstrated that good quality sugar beets can be grown in the Peshawar Valley.

(2) *Cultivation.*—The sugar beet followed wheat and the land was thoroughly cultivated between 15th June and 1st October. The soil was deep, red, free working, sandy loam, typical of the greater part of the Peshawar Valley. Manure was not given. The sowings were made on 15th October and 15th November, and although the light frosts and cold winds of December and January checked the development of the plants, the roots from the October sowing appeared to be fully developed in early April.

COST OF CULTIVATION PER ACRE.

Labour at annas 7 per man per day.

		Rate. Rs.	a.	p.
1. Ploughing	(a) Double depth with Rajah	3	0	0
	(b) 3 country ploughings @ Rs. 1-4-0 each	3	12	0
2. Harrowing 3 times @ Rs. 0-4-0 each		0	12	0
3. Levelling 1 time @ 1-4-0 per day		1	4	0
4. Drilling 1 time @ annas 10 per day		0	10	0
5. Irrigation	(a) Preparation of water courses 2 men one ½ day	0	7	0
	(b) 6 times 2 men six ½ days	2	10	0
6. Singling and Hand Weeding. (3 times 7 men 3 days)		0	3	0
7. Cultivating. (4 times with Planet Junior Hand Hoes 2 men for 4 days)		3	8	0
8. Raising 8 men 1 day		3	6	0
9. Carting 15 ton crop 1 mile 5 days @ Rs. 2-8 per day		12	8	0
10. Seed 7 lbs. @ annas 7 per lb.		3	1	0
11. Rent Rs. 14 per acre		14	0	0
12. Revenue		5	0	0
13. Irrigation		7	0	0
	TOTAL	70	3	0

(3) ***North-West Frontier Province Rotations.***—Wheat, barley, maize, ***shaftal***, cotton and sugarcane are the staple crops in the lower irrigated valleys of the North-West Frontier Province. Roots are grown within a radius of five miles of Peshawar, and the straight, clean drills which are set up by busked country ploughs are suitable for the production of beet roots. Sugar beet after wheat is one of the most frequently practised rotations in Europe, and a root crop would follow ***shaftal*** with unusual advantage, as the land after that leguminous crop is vacant in ample time for August and September sowings. Maize is manured and ripens in time for *October and November sowings.*

(4) *Labour.*—There is plenty of strong and cheap labour available in Peshawar from early October to late May when the country-side is overrun by trans-border families, and the local men and women are also accustomed to work in the fields. The pathan's methods of work are well adapted to the cultivation of beets and he is strong and intelligent.

(5) *Roads and Cartage.*—The big, heavy, wooden-wheeled bullock carts of the Frontier negotiate the roughest roads and they would have no difficulty in conveying beets from the fields to a central factory.

(6) *Insect Pests.*—A species of "Jassid" was present in abundance in June when the roots were being analysed and as this pest sucks the juices of the beet leaves, it is possible that the quality of the roots might be deleteriously affected.

(7) *The character of the seasons in the Peshawar Valley.*—Four seasons are recognised in the Peshawar valley.

Spring.—In February, March and April. During this season rain falls in the first two months to the extent of three or four inches in the aggregate. The air is cold and bracing and the temperature is as follows :—

Spring.	In Shade.	
	Maximum.	Minimum.
February	64·2	42·6
March	70·0	49·5
April	85·5	62·1

Summer.—In May, June and July. This is the hottest season of the year. The temperature is as follows :—

Summer.	In Shade.	
	Maximum.	Minimum.
May	[illegible]	71·7
June	[illegible]	77·9
July	[illegible]	78·2

Autumn.—In August, September and October. This season is ushered in by the [illegible] rains. They break over the valley in four or five violent storms at intervals of a few days, and two or three inches fall on each occasion. The temperature is as follows :—

Autumn.	In Shade.	
	Maximum.	Minimum.
August	[illegible]	[illegible]
September	97·7	62·7
October	[illegible]	60·5

Winter.—In November, December and January. During this season the weather is [illegible] and light rain falls. The days are sometimes hot and the nights always cold. The temperature is as follows :—

Winter.	Sun's Rays.	
	Maximum.	Minimum.
November	74·3	44·7
December	67·7	41·3
January	60·3	42·2

(8) *General.*—That there is room for an improved source of sugar in the North-West Frontier Province is proved by (*i*) the high price of sugar and (*ii*) the fact that the sugar-cane crop, although of good quality, is not only a small one in this Province, but also because the season during which that crop is in a fit state for crushing is limited to the months of November and December.

(*i*) The price of sugar during the past three years has ranged between Rs. 11-12-0 and Rs. 13 per maund of 100 lbs. and the present price is Rs. 12-3.

(*ii*) The sugar cane crushing season begins on 15th November and every effort is made to finish by the end of December when light rainfall is frequently followed by severe frost.

(9) ***Probability of success of Industry.***—It is naturally not possible for us to offer a detailed estimate of the cost of production of sugar beets in the Peshawar valley at present, nor the cost of manufacture of sugar but such data as are available lend considerable support to the idea that the industry should be profitable. This will be best appreciated from the following :—

(*i*) The average outturn of beets in Europe is 10 tons ; or excluding Austria-Hungary and Russia it is 11·5 tons per acre. Belgium has the highest average namely 12·1 tons. The recent crop at Tarnab was about 10 tons.

(*ii*) The quality of the roots grown at Tarnab namely 15 per cent. sucrose is about equal to a European average figure.

(*iii*) *The cost of manufacture in Europe is about 25s. (Rs. 18-12-0) per ton of clean beets, of this sum about* 18*s*. (Rs. 13-8-0) is paid for the roots and 7*s*. (Rs. 5-4-0) is the cost of wages and coal.

Depreciation is estimated separately. Of the 7*s*. about 1*s*. 8*d*. (Rs. 1-4-0) is the cost of coal and 5 *s*. 4 *d*. (Rs. 4-0-0) the cost of salaries and wages. The cost of sugar in Europe has varied a good deal but has risen on the whole of late years and in 1910 was 12*s*. 9*d*. per cwt. (112 lbs.) equal to Rs. 8-7-0 per 100 lbs. The average price of sugar at Peshawar during the last three years has been Rs. 12-6-0 per 100 lbs. The cost of coal at Peshawar would be half as much again as in Europe, say Rs. 1-14-0 and the cost of wages, bearing in mind that a large portion must be paid to European experts, would be also much higher,—say Rs. 6. The cost of producing sugar beets should not be any higher, in fact it might be expected to be less. The estimate for Peshawar may be put thus :—

	Rs.	*a*.	*p*.
Cost of 1 ton roots	13	8	0
Coal	1	14	0
Wages	6	0	0
	21	6	0

The sugar from 1 ton roots may be expected to be about 310 lbs. valued at Rs. 38. The depreciation must be put rather higher for India than for Europe, say Rs. 2-0-0 but this would still leave a margin for profit quite as great as is expected in Europe. It is hardly necessary to again state that such estimates are open to considerable criticism, but they will serve the purpose of showing that a sugar beet industry is financially possible. If the manufacture could be linked with sugarcane, the manufacturers' position would be materially strengthened.

APPENDIX—D.

Subject VIII.—Notes on Rice Investigations in different Provinces.

BENGAL.

(THE DIRECTOR OF AGRICULTURE.)

As regards future lines of work I beg to make the following suggestions :—

I.—(*a*) On the agricultural side irrigation for winter rice in the Burdwan Division is a question demanding serious consideration. The sinking of wells and the raising of water by some cheap method are very pressing problems.

(*b*) The demonstration of green manuring on one cropped land and bonemeal on double cropped land ought to be extended as far as possible. We have made a good beginning in the District of Mymensingh.

II.—On the chemical side I think that the work done by Mr. Hooper in analysing the composition of different varieties of rice might be extended. Only thirty of the varieties analysed by Mr. Hooper belong to this province. This is necessary for the purpose of knowing definitely what varieties which have a large yield per acre have also a high nutritive value. It is also necessary to have a soil analysis of the different classes of soil in the various districts of the province in order that we may have some general idea of the probable effect of the application of artificial manures. Samples of soil will be sent to the Agricultural Chemist with this object. A third matter is the question of analysis of the various items of cattle food on the Rangpur dairy farm in order that we may arrive at the most nutritive ration consistent with economy. Samples will be sent to the Agricultural Chemist for analysis.

III.—On the Botanical side Mr. Hector is engaged in isolating pure seed of the best yielding varieties. More attention, however, ought to be paid to the selection of the best seed from the ryots' fields. The touring agricultural officers, and especially the demonstrators, have got orders to be constantly on the look out for valuable strains for the purpose of getting the very best possible existing seed.

(MR. F. SMITH, DEPUTY DIRECTOR OF AGRICULTURE.)

(1) The following experiments have been and are being carried out on winter rice :—

A.—Manure.

B.—Variety.

C.—Methods of cultivation :—

(1) *Implements.*—Iron ploughs *versus* Country ploughs.

(2) *Sowing.*—(*a*) Thick and thin sowing in broadcasting.

(*b*) Thin and thick sowing in seedbeds for transplants.

(3) *Planting.*—(*a*) Distance apart in transplanting.

(*b*) Number of seedlings per hole in transplanting.

D.—Rotations.

As a result of all the work that has been done on this crop in Bengal we are able to make the following definite conclusions :—

A. Manures.—The problem of manuring the rice crop is essentially one of the locality, the individual cultivator and the soil. No general recommendation, applicable by every cultivator, can be made for the whole Province. The most important factor for this crop is water.

One general conclusion however can be made and that is, that generally speaking, an application of 50 maunds of cowdung per acre is an economical application for the rice crop.

The following is an average composition of cowdung in Bengal :—

Nitrogen	·5 per cent.
Phosphoric acid	·3 „ „
Potash	·4 „ „
Organic matter	·26 „ „

An application of 50 maunds of cowdung per acre therefore supplies the following amounts of plantfood to the soil :

	lbs.	
Nitrogen	$20\frac{1}{2}$	per acre.
Phosphoric acid	$12\frac{1}{3}$	
Potash	$16\frac{1}{3}$	
Organic matter	1,066	

It should therefore follow that any manure that supplies, approximately, the equivalent amount of plantfood per acre as 50 maunds of cowdung, ought to have the same effect on the rice crop.

Wherever 100 maunds of cowdung per acre were compared with 50 maunds there was no corresponding increase in outturn of the crop ! How can this be explained ? Where did the extra plant food go ? This may be explained by the nitrogen being destroyed by denitrification. Do the bubbles that we see coming off in the water in the Paddy fields denote a loss of free nitrogen gas and show that organic nitrogen is being destroyed ? We must await the Chemist's investigations on this subject. Generally speaking then it may be said that heavy manuring is not necessary for the rice crop. A small application is quite sufficient either as cowdung or green manure or castor cake or fish manure, etc.

Special manures such as bonemeal should be very carefully employed. In some cases they will have no effect whatsoever. How can they if the soil to which they are applied contains already sufficient phosphoric acid and lime ?

Artificial manures which are soluble in water should also be very carefully employed. If not the water will carry away the plant food to the drains and rivers and not to the rice plant.

B. Varieties.—There are many varieties of paddy in Bengal. Each locality, each kind of soil and each elevation has its own variety. At the Calcutta Exhibition in 1906-07 the late Mr. N. G. Mukherjee showed 1182 named varieties. Generally speaking the variety that is grown by the Bengal cultivator is a medium to coarse variety and the local favourite is the heaviest yielder and therefore the most economical for that locality. The Agricultural Department can recommend two fine varieties, *viz.*, *Dadkhani* and *Badshabhog* for anyone who cares to cultivate fine varieties. The cultivator is recommended at harvest time to select the heaviest heads of rice and to keep same for his seed supply in the following year.

The Botanist is trying to create heavier yielding varieties by cross breeding and his work is progressing but at present he has not yet reached that stage that the Department can make any definite recommendation.

C.—Methods of Cultivation—

(1) *Implements.*—The local country plough does good useful work and so long as the cultivator can obtain it so cheaply as at present there is no incentive for him to change.

When ploughs become dearer the cultivator can purchase an iron plough (Meston at Rs. 6, Hindustan at Rs. 12) from Messrs. Burn & Co., Howrah, who are ready to supply any demand in Bengal.

(2) *Sowing.*—(*a*) Broadcast. In broadcast sowing there is no need to use more than 80 lbs. of seed per acre.

(*b*) Seedbeds.—Thick or thin sowing. There is no definite statement to be made at present as to whether thick or thin sowing on seedbeds is the best. $\frac{1}{7}$ of an acre sown with $\frac{1}{4}$ maund seed gives sufficient plants to transplant 1 acre of land. Economically therefore the subject is not very important.

(3) *Planting.*—(*a*) Distance apart in transplanting.

(*b*) Number of seedlings per hole in transplanting.

Both problems (*a*) and (*b*) affect each other. Generally speaking it is better to transplant a large number of seedlings farther apart and a small number closer together.

(*a*) However, it is better to transplant 2 to 4 seedlings per hole one foot apart.

(*b*) *The number of seedlings per hole in transplanting is governed by the time of planting. If time of transplanting* is early, one seedling per hole is the best. If time of transplanting is late, 3 or 4 seedlings per hole is best. It is found in practice that there is some trouble in selecting out one seedling per hole and that it is more simple to grasp 2 or 3 seedlings in the act of transplanting. There is however no need to *transplant* more than 3 seedlings per hole under any consideration.

D. *Rotations.*—In many localities jute can precede the rice crop while in most places a *rabi* crop such as gram or *khesari* can follow the rice crop.

Autumn rice.—Little work has been done on this crop except on varieties. The above remarks on the varieties of the winter rice crop hold good for this rice.

Summer rice.—No work has been done on this crop by the Department.

So far as fungus and insect pests on the rice crop are concerned, a certain amount of damage is done and the attack of *Ufra* on rice which is caused by an eel-worm seems to be large but we have no definite data at present of the amount of damage done or of the area affected by these different pests.

(Mr. G. P. Hector, Economic Botanist.)

(1) The botanical work in progress on rice has for its chief object the isolation of pure seed of the best yielding varieties of the Province. Varieties have been collected from practically all the districts of Lower Bengal, and pure line cultures started from single selected plants. These pure lines are being studied in detail and a classification based on morphological and field characters is being made. Incidentally, the extent to which natural cross-fertilisation takes place is being worked out, as this has an important bearing on seed distribution, and cross-fertilisation experiments are also being commenced with the object of determining the mode of inheritance of certain characters. Attention so far has been almost confined to transplanted *Aman* paddies, but work has also been begun with *Aus* varieties.

The work already promises to yield practical results of value. This last season, the outturn of all the pure line plots grown in our area together amounted to 32 maunds from 1·15 of an acre and if the area had been uniformly cropped with one of our best yielding types, the yield would have approached 40 maunds, on land which has never been manured. The average yield of *Aman* paddy on the Dacca Farm for the same year was about 20·5 maunds an acre.

(2) In Bengal the question of quality is not of such importance as yield, but there is one important question which is being investigated as part of the general study of varieties, *viz.*, how far composition of the grain is correlated with varietal and field characters. This is being done in conjunction with the Agricultural Chemist.

(3) Experiments have also been commenced in *Aus* paddy in the specific gravity method of seed selection. This has yielded results of value in Japan and also in Mysore, where it has proved a very simple and economical method of increasing outturn. *The average sample of Aus seed paddy sown by the ryot in Bengal is very poor,* as apart from being very mixed, it always contains at least 25 per cent. of light and shrivelled grain. This method of seed selection should therefore prove of value, particularly in connection with the *Aus* crop.

(4) The most important disease of paddy in Bengal is the so-called *Ufra* disease which according to the investigation of the Imperial Mycologist appears to be due to a minute eel-worm. This disease is very prevalent on inundated paddy tracts practically all over the Dacca and Chittagong Divisions, and does much damage to the broadcasted *Aman* paddy of these tracts. Where the disease is prevalent the cultivator is lucky if he gets a 4-anna crop. The only practical remedies appear to be (1) burning all stubble left in the field after harvest, (2) cold weather cultivation, (3) sowing good seed. *Experiments in the above are being conducted in Ufra infected areas.*

As only the *Aman* crop appears to suffer, wherever possible the cultivator should also be encouraged to grow transplanted *Aman* after either jute or an *Aus* crop, instead of the present mixture of *Aus* and *Aman*. Experiments in this are also being conducted.

So far as is known there are no fungus pests of any importance. Insect pests are prevalent and frequently do much damage, particularly the Rice-stemborer, Ear-cutting caterpiller, Rice-hispa, and Rice grass-hopper but these are prevalent all over India and are in no way peculiar to Bengal. Advice and help in combating these pests are given to the ryot as far as is possible.

(The Agricultural Chemist.)

Up to date I have not made any special investigations from the chemical side in connection with the rice crop. I am, however, in co-operation with Mr. Hector, Economic Botanist, Bengal, about to take up at once some aspects of these questions. Mr. Hector has been making pure line cultures of paddies for the past few years and has now isolated several varieties differing more or less in morphological characters, in time of maturation, etc. I am now about to commence work with the view of finding whether any well marked chemical differences in grain composition accompany these different field characters, and if so whether these chemical features are as fixed as the botanical ones, or whether within the limits of any one variety, other factors such as climate and soil have any marked influence on the composition of the grain.

BIHAR AND ORISSA.

(The Director of Agriculture.)

(1) The Deputy Director of Agriculture is at present busy with the following investigations regarding rice :—

(a) *The spread of good varieties of rice.*—Fine and valuable varieties of rice from the best tracts in Bengal are being introduced in places where they seem to be able to grow well and to be better than the local rice.

(b) *Savings in seed rates.*—It would seem that the seed rate for broadcast rice is usually too high; the matter is being investigated.

(c) *Savings in seedlings.*—About eight seedlings or more are usually transplanted in one bunch. It appears that two seedlings give as good an outturn so far as experiments have yet gone. Experiments have however always been carried out on irrigated land and at the usual time of transplanting. Experiments are being undertaken to find out whether it is safer to transplant more seedlings on unirrigated land or when the date of transplantation is late.

(d) *Manuring.*—The question of the best general manure for rice is being investigated, with the object of finding cheap but efficient dressings of more or less general utility.

(e) Various manures are being tried at Cuttack to see whether they tend to check the spread of the disease prevalent there; this work is being done in collaboration with the Agricultural Chemist.

(2) The Agricultural Chemist is making a detailed survey of the soil of the Cuttack District for growing rice.

(3) The following points are engaging the attention of the Professor of Agriculture who is in charge of the Sabour Farm.

(a) *Seed bed.*—I.—Dry sowing *versus* wet sowing.

II.—Conditions under which wet method is advantageous.

III.—Effect on the strength of seedlings when sown by dry and wet methods.

IV.—Forcing (by manures) of seedlings in seed bed.

V.—Length of time seedlings can be kept alive after uprooting.

VI.—Effect of root pruning.

VII.—Best age of seedlings for transplantation.

(b) *Planting*—

I.—The minimum number of seedlings required to be transplanted per hole for a maximum yield.

II.—The minimum number of seedlings required to be transplanted per hole for a maximum yield when transplanted late in the season.

III.—Determinations of the conditions which affect tillering of the paddy.

IV.—Broadcasting *versus* transplanting *versus* drilling.

(c) *Manuring*—

I.—Green manuring with San-Hemp.

II.— „ „ „ „ *Dhaincha.*

III.—Bonemeal.

IV.—Oil cake.

V.—Farm yard manure.

VI.—Ashes of farm yard manure.

VII.—Magnesium Sulphate (only applied to early and late *Aman* paddy).

VIII.—Determination of the lasting effect of green manuring on early *Aman* crop.

(d) *Double cropping.*—The advantage of taking an early San-Hemp crop for fibre before the late *Aman* crop.

(4) No botanical work on rice has been done. A full account of the pests that occur on rice in Bengal, Bihar and Orissa is given in the crop pest Hand Book by Mr. E. J. Woodhouse, Economic Botanist. The book is in the press.

(5) Mr. McGowan, Professor of Agriculture, Sabour suggests that investigations on the following points may be taken up with advantage :—

(a) Quantity of water required for *Aus* and *Aman* Paddy.

(b) Effect of water on the quality of rice.

(c) Does the application of manure or any particular treatment of paddy lands influence the water requirement.

(d) Dry planting and then occasional flooding as is practised in United States of America.

(e) Drainage of Paddy lands—Nigar *versus* no Nigar.

(f) Determination of influence of a leguminous crop, *e.g.*, *Khesari* gram on paddy.

UNITED PROVINCES.

(The Director of Agriculture.)

The principal work undertaken in this department in connection with the rice crop is the extermination of the rice bug (*leptocorisa varicornis*) which does enormous damage in certain years to the crop.

The work at the Agricultural stations consists principally of varietal and manurial experiments, which are mainly of local significance, and experiments to determine the optimum number of seedlings on transplantation and the spacing between them.

In addition to the pest mentioned above, a great deal of damage is done by the rice grasshopper; while occasionally reports are received which seem to indicate attacks by the rice stem fly. No information is available about the fungoid diseases of rice in these provinces. The opening of farms in the rice growing tract of these provinces is of recent date and not a great deal of work has so far been done in connection with this crop.

THE PUNJAB.

(The Director of Agriculture.)

The total area annually put under rice in the Punjab is a little under 800,000 acres or about 2½ per cent. of the total area under crop. It is not therefore a crop of great importance. The chief tracts with approximate maximum areas in which it is grown are as follows:—

District.	*Area in acres.*
Karnal	60,000
Umballa	70,000
Kangra	120,000
Hoshiarpur	35,000
Lahore	40,000
Amritsar	40,000
Gurdaspur	60,000
Sialkot	65,000
Gujranwala	60,000
Muzaffargarh	45,000
Dera Ghazi Khan	60,000

2. The conditions under which it is grown vary considerably. In Karnal and Umballa the rice is usually unirrigated but a good deal is also grown on the stiff low-lying Naili lands along the Ghaggar and other streams, in part of which there is an intricate system of irrigation by cuts from the Ghaggar. In Kangra most of the rice is grown in terraced fields on the edges of the many hill streams, which traverse that district, and is irrigated by water channels taking off from the streams. In Hoshiarpur and Gurdaspur the swamp lands stretching for miles along the Bias and Ravi rivers are covered with rice. There are also large tracts of canal irrigated rice in the Pathankot Tahsil. In Lahore and Amritsar the crop is irrigated by the Upper Bari Doab Canal. In Sialkot and Gujranwala it is grown largely on the flooded lands on the Aik and the Deg streams, in marshy lands along drainage channels and on sour clay soils. In Muzaffargarh and Dera Ghazi Khan the rice is watered by the inundation canals taking off from the Indus and Chenab rivers.

3. The crop is generally manured. In the case of the finer rices (*basmati*, *begami*, *ziri*) seedlings are reared in beds—often well-irrigated—and then planted out in June and July. The coarser rices (*jhona*, *dhaulu*, *dhain*, *sathi*, *munji*, *kharsu*) are frequently sown broadcast in April. Often the seed for broadcasting is kept damp till it germinates and then sown. In almost all districts both systems of sowing and of planting out are generally practised.

In Kangra the irrigated rice is sown in seed beds and then planted out; the unirrigated rice is sown broadcast. When the rice is sown broadcast it comes up thick and mixed with weeds. In July or August when the crop is 4 to 8 inches high the plough is run through it and the whole field ploughed up. After this the rice is much thinner on the ground but is free from weeds and tillers well.

Rice is generally sown year after year in the same land. It is frequently followed by gram or by wheat or barley. In Kangra linseed is a favourite crop after rice.

4. The local varieties of rice are numerous. The following are the local names and characteristics of the most important:—

District.	Vernacular name of rice.	Characteristics.
Karnal	Ziri	Fine. Small rice with short straw.
	Chaluka	White grain with broad husk of a purplish red colour at the tip and longish beard of same colour.
	Munji	Coarse.
	Sathi	Coarse red rice: ripens in 60 days; hence its name. Husk dark: ripens within the sheath.
	Dhaulu	Larger grain than *sathi* and the grain stalk, when ripe, separates from the sheath.
Amballa	Ziri	} Fine.
	Chahora	
	Dhaulu	} Coarse.
	Sathi	
Kangra	*Begami*	} Fine.
	Basmati	
	Kathiri	} Coarse.
	Kolhera	
Hoshiarpur	Basmati	} Fine.
	Chorara	
	Begami	
	Munji	Coarse.
	Kharsu	Very coarse: grown in poor alluvial soil.
	Sathi	Coarse.
Lahore	Mushki	Fine; scented.
Amritsar	Safeda	Fine; white.
	Dhain	} Coarse.
	Kharsu	
Gurdaspur	Begami	Fine; white.
	Munji	Coarse; red.
	Sathi	Coarse.
Sialkot	Mushki	Fine; scented.
Gujranwala	Basmati	Fine.
	Munji or jhona	} Coarse; white: with large grain.
	Dhain	
	Kharsu	Very coarse.
Muzaffargarh	Sathri	Coarse.

5. The agricultural department in the Punjab has not yet taken up either the botanical investigation of varieties or the survey of the different types grown in different localities. Nor have the methods of cultivation been studied. As soon as we have more Deputy Directors a survey of the rices of the province should be carried out, the botanical characteristics of the different types determined and experiments made in cultivation, manuring and rotation. The cultivation experiments could be carried out in leased lands near Gurdaspur.

6. There has been no special investigation as to fungus and insect attacks on rice. The following have been reported in recent years :—

Kangra . . . / Ferozepore . . .	Rice bug . . . . . (Leptocorisa varicornis).	1912 slight attack.
Kangra . . .	Rice grasshopper (Hieroglyphus fureifer).	1912 slight attack.
Lahore . . . / Amritsar . . .	Rice bug	1909 general.

BOMBAY.

(MR. G. S. HENDERSON, DEPUTY DIRECTOR OF AGRICULTURE.)

The rice crop is being dealt with in only one farm in Sind, at Larkana. This farm has just been newly opened, it is in the centre of the best rice district in Sind. The problems to be worked out are :—

I.—*Cultural* (a) The suitability of growing catch pulse and leguminous fodder crops, after the rice has been harvested, in the cold weather.

(b) The best crops for this purpose.

(c) Effect of winter cultivation.

(d) Single transplantation.

II.—*Varietal* (a) The above experiments are in duplicate to test the main crop rices against the early varieties.

(b) Trial of any superior varieties from other provinces.

(c) Investigation of a high priced scented variety locally known as *Peshawari*.

III.—*Manurial*.—Effect of artificial manures.

IV.—*Irrigational*.—Amount of water required for *rice cultivation*.

(THE ASSISTANT ECONOMIC BOTANIST.)

The problem in connection with the botanical work relating to rice is, in what manner the numerous varieties of that crop can be systematically classified. The chief difficulty of that work lies in the fact that the botanical aspect of the question is so intimately connected with the Agricultural and Physical aspects that it is practically impossible to study the first without paying any attention to the second and the third. The truth of this can be easily seen if we take into consideration the extremely gradual gradation existing between two opposite extremes of characters showing size and shape of the spikelet and its glumes, consistency of the grain, colour of the grain and husk, presence or absence of the awn, time of flowering and ripening of the varieties and conditions of soil, climate, rainfall and altitude in which the varieties grow and which also more or less influence their growth; to say nothing of the nature of the stem, leaves, leaf-sheaths and inflorescence, and the probable natural crossing. Such being the state of things the work done in this line so far has been :—

(1) To collect a great number of varieties grown throughout the Presidency together with information regarding their cultivation, duration, time of harvesting, uses, and requirements as regards soil, water, etc.

(2) To sow the seeds first at Lonavla and now at Alibagh.

(3) To make a few pot-culture trials to see if the colour of the grain produced by the offspring showed any change from that of the parent. This was done by actually removing the husk to be able to see the colour of the grain and then sowing the same.

(4) To takes notes of the average measurements regarding height of the plants, length and breadth of the leaves length of the peduncle and inflorescence, size, weight and colour of the grain, colour of husk, presence or absence of the awn and time of flowering and harvesting of the varieties.

(5) To sort out a single head of each variety for seed for the coming season so that the varieties may be grown on pure lines.

(6) To prepare mounted specimens from single heads of the varieties for future comparison.

The points noted during the last year were :—

(1) The colour of the grain in two or three instances, in the pot cultural trials was changed from white to red and red to white.

(2) There are at least three or four distinct grades in the redness of the grain (seed not husk) sometimes even in the same panicle.

(3) The so called early and late varieties did not necessarily always remain so thus :—

Name of variety.	Plots sown last year.	No. of varieties that remained true to the name.	No. of those that remained nearly true.	No. of those that changed.
T. E.	67	45	5	17
T. L.	85	45	11	29
B. E.	8	3	3	2
B. L.	38	25	2	11

No very violent change as regards the colour of the husk and the size and shape of the spikelets was noticed. Such change was noticed as regards the size of the awn.

Work proposed to be done during the coming season :—

1. Growing the same varieties from one panicle of each collected last year and taking notes as before and comparing them with last year's notes.
2. Growing a few typical varieties in several stations (Surat, Alibagh and Gokak) in different climatic conditions.
3. Study of certain of the varieties in their proper districts.
4. Study of the amount of variation in the offspring of one plant.

5. To start a few pot cultures for growing varieties having the following characters·

(1) Longest and narrowest grain (slender oblong),
(2) Shortest and broadest grain (short round),
(3) Latest ripening large grain,
(4) Earliest ripening small grain,
(5) Yellowish white grain,
(6) Chalky white grain,
(7) Dark red grain,
(8) White husk,
(9) Red husk,
(10) Brownish black husk,
(11) Awns,
(12) No Awns,
(13) Large outer glumes,
(14) Small outer glumes,
(15) Very small panicle,
(16) Large panicle,
(17) Finest grain,
(18) Coarsest grain,

and to give them the following treatment:—

(Some treatment for opposite characters.)

Dry conditions: very little water and bad drainage; plenty of water and good drainage.
Wet conditions: Plenty of water and no drainage; stagnant water, moving water.
Salt conditions: Salt and water.

6. To try a few crosses.

7. To study if possible the wild rices in their native places.

The object in introducing these experiments is to find out if the varieties remain constant or are gradually changing. (Expt. 1.)

If the varieties change at all what particular change is influenced by a particular condition of soil, climate and rainfall. (Expt. 2.)

Comparing the characters of the same varieties growing in their own districts with those grown in other places. (Expt. 3.)

To find out the limits of variations. (Expt. 4.)

To examine under controllable conditions, what changes are brought about by dry, wet and salt conditions on different varieties. (Expt. 5.)

To see if natural crossing actually takes place and if so what are the forms evolved by the various crosses. (Expt. 6.)

To see to what extent there is connection between the wild and the cultivated forms. (Expt. 7.)

(The Assistant Professor of Mycology.)

The only fungoid diseases of rice which have come within my notice so far are:—

(1) Ustilaginoidea vireus (cke) Tak. (Green "smut.")
(2) Ephelis sp. locally known as "Musalya" disease.

Both of these are sporadic and occur rarely.

(Mr. J. B. Knight, Professor of Agriculture.)

There are many problems in connection with rice cultivation in this Presidency such as implements, manures and *better varieties but there is only one rice problem* that I have had *opportunity to investigate to any* great extent. I refer to the questions in connection with *rab*.

Rab is the treatment given to the seed bed and usually consists in burning such materials as cowdung or branches. My investigations have been carried along on two lines (*a*) as to what the beneficial effects of the *rab* are due to and (*b*) to find substitutes. On the first point I think that the value of *rab* is without doubt due to the heating of the land and my experiments indicate that the heat acts biologically.

For substitutes I have found that nitrogenous manures like oil cakes, fish, poudrette and crude nitre are equally valuable to *rab* and in some cases as cheap.

(Mr. V. H. Gonehalli, Extra Deputy Director of Agriculture.)

Note on *the "agricultural" problems that are being investigated at the Alibagh Experimental Farm.*

I.—Manuring.

1. *Green manuring by transfer method.*—San (*Crotalaria juncea*) and Dhaincha (*Sebania aculeata*) should be grown on highlying land and the green plants transferred to lowlying rice lands. Green manure seed should be sown on the 25th of May and the green stuff transferred to the rice lands five days previous to transplanting them with rice seedlings in July.

2. *Green manuring by growing san and dhaincha in rice lands in the kharif season.*—San and Dhaincha should be sown on rice lands on the 25th May and the crop ploughed down *in situ* five days previous to transplanting rice seedlings. Transplanting is done in July. The green manure crop will have five to six weeks' growth.

3. *Green manuring in the rabi season by sowing san and dhaincha seed after harvesting rice crop.*—San and Dhaincha should be shown soon after harvesting rice crop and ploughing the fields. The green manure crop should be broken and ploughed down when in flower.

4. *Green manuring in the rabi season by sowing san or dhaincha seed in the standing rice crop a fortnight before harvesting.*—The green manure crop should be broken and ploughed down when in flower.

5. *Bonemeal as manure for rice.*—Bonemeal at the rate of 20 lbs. N. per acre should be applied at the time of puddling or "chikal" making and then rice seedlings transplanted.

6. *Bonemeal in conjunction with the green manure of san for rice.*—San seed should be sown on the 25th of May and the crop ploughed down five days previous to transplanting rice seedlings. Bonemeal at the rate of 20 lbs. N. per acre should be applied at the time of puddling.

7. *Oilcakes as manure for rice.*—Castor, groundnut and *Karanj* cakes should be applied at the time of puddling at the rate of 20 lbs. N. per acre and then rice seedlings should be transplanted.

8. *Fish manure for rice.*—Fish manure at the rate of 20 lbs. N. per acre should be applied at the time of puddling and then rice seedlings transplanted.

9. *Bulky manures for rice.*—Mohra refuse, rice hulls, poudrette and urine earth should be applied at the rate of 20 lbs. N. per acre. The first three should be applied at the time of first ploughing and rice seedlings transplanted after puddling. Urine earth, however, should be applied at the time of puddling and rice seedlings should be then transplanted.

II.—Transplanting.

10. *The minimum number of ordniary rice seedlings to be transplanted in each bunch.*—Ordinary seedlings are raised by sowing seed at the rate of 12 lbs. per guntha of *rabbed* seed-bed. Seedlings—16, 8, 4, 2 and 1 in each bunch—*should be transplanted in separate plots at 9" both ways.*

11. *The minimum number of strong seedlings to be transplanted in each hole.*—Strong seedlings are raised by sowing paddy seed (thinly) at the rate of 4 lbs. per guntha, *i.e.*, one-third of the ordinary rate. Seedlings—16, 8, 4, 2 and 1 in each bunch—should be transplanted in separate plots at 9" both ways.

III.—Rab.

12. *Rab-substitutes.*—Rice seedling should be raised by sowing seed on unburnt seed-beds to which fish manure, *Karanj* cake and urine earth are applied at the rate of 2·5 lbs. N. per guntha. These seedlings and also seedlings raised on seed-bed burnt with cowdung *rab* should be transplanted in four separate plots with duplicates and the outturns noted. The ground selected for the application of fish manure, *Karanj* cake and urine earth should be that which was burnt in the previous year with *rab* materials.

IV.—Seed selection.

13. Ordinary seed belonging to cultivators, seed selected by the salt water method of Japan and also that selected *by plant to plant selection should be sown on rabbed seed-beds, and the seedlings transplanted on* comparative plots to ascertain outturns.

V.—Varieties.

14. *Testing of outturns of a few local varieties in comparison with some varieties obtained from Madras and Nagpur.*—Seedlings of *Banku, Rascadum, Gurmatia, Bhadas, Patni, Ghosalwel, Kolamba* and *Halwa* should be raised and transplanted on comparative plots to ascertain outturns.

VI.—Tillage.

15. *Ploughing rice land in the fair season as compared with monsoon tillage.*—At present rice land in the North Konkan is left unploughed in the fair season and ploughing is commenced only after the break of rains. The two methods of tillage should be tried on two plots with duplicates and rice seedlings transplanted with a view to ascertaining outturns.

Note.—The Alibagh Farm where the above problems are being investigated is situated in the trap area of the Konkan. The newly sanctioned Ratnagiri Farm will be utilised for studying similar problems in the laterite track of the Konkan.

MADRAS.

(THE DIRECTOR OF AGRICULTURE.)

I have the honour to furnish below a brief, but detailed account showing the work done or in progress in Madras on the Agricultural side of the problems connected with the rice crop which are being investigated by this Department.

I.—Improvement of varieties by selection of strains. In all the more general varieties applications for seed are now supplied entirely from stocks of selected seed. One of the selections raised from a single plant promises to be a marked improvement upon the main variety.

II.—Comparison of (*a*) local varieties, (*b*) varieties from other districts, (*c*) varieties from other parts of India. Of these latter *Rascadum* from the Central Provinces is becoming increasingly popular with Mahomedans.

III.—The advantages of a thin seed bed and transplanting the singly or at most in twos and threes instead of in bunches to 20 or 50 has passed the stage of experiment and is now regularly recommended and is steadily being adopted throughout the Presidency. Work is now in progress to find the optimum distance and age at which to transplant such seedlings and the optimum seed rate in the nursery. On all ordinary lands 6 inches apart appears to give the best results. The other questions are being tested.

IV.—The effects of different manures on the crop—(*a*) those ordinarily used or obtainable, (*b*) definite quantities of Potash and Phosphorus in conjunction with green manure crops ploughed in, (*c*) the comparison of the value of different green manure crops—natural manures are becoming costly as also in green leaf—and (*d*) testing the effect of castor cake alone and in conjunction with definite quantities of phosphate and potash. Consequently efforts have been made with considerable success to induce ryots to grow green manure crops on their own lands and plough them in gree , *Daincha, sann*-hemp, *Kulinj*. (*Tephrosia*) have all succeeded on soils possessing good subsoil drainage. Experiments are in progress to discover the best means of introducing this system on the heavy undrained delta soils where the usual methods have not succeeded.

V. Trials to find out the most economical method of growing green manure crops.

VI. Testing the effect of cultivating the land during the hot weather and of puddling, and also the effect of drainage and the movement of the water in the soil and subsoil. This question of drainage is of first importance if green manuring is to be successful on fine delta soils. The work of Mr. Harrison has direct bearing on this question.

VII. Testing the various 2nd crop paddies against one another.

VIII. Comparing the different varieties of paddies grown under partially dry conditions.

2. As regards the chemical side of the problem I enclose a copy of the note prepared by Mr. Harrison on his investigations into the conditions affecting the cultivation of paddy under swamp conditions. He has brought together the result of his work and is submitting to Pusa for acceptance as a memoir. I have seen the first draft and it throws considerable light on some of the factors essential for the growth of paddy.

3. Dr. Barber is engaged on sugarcane and Mr. Parnell has just arrived. No work has as yet been done on the botanical side of rice.

4. With reference to paragraph 2 of your letter under reply, I have the honour to enclose a copy of a note from the Government Entomologist on the insect pests of paddy in Southern India.

5. Of fungoid disease, smut upon which Mr. McRae is working causes most loss especially in the Kistna and Godavari delta. *Sclerotium oryzae* Catt. has also been found at Samalkota. Mr. Shaw has already investigated that in Burma.

6. These enquiries cover much of the ground of economic importance in Madras in connection with paddy, and the questions of manuring, drainage and seed rate are fundamental. In addition, breeding or discovery of good rice capable of withstanding shortage of water would be of immense benefit as the supply of water in so many of the tanks of the presidency is frequently very precarious. This problem is however complicated by the distinctions drawn by different communities and people of different districts between the flavours of different kinds of rice. The kinds readily taken by one set of people are unpalatable to another.

(Mr. W. H. Harrison, Agricultural Chemist.)

Investigations into the conditions affecting the Cultivation of Paddy under swamp conditions by the Government Agricultural Chemist, Madras.

Although irrigated paddy is generally grown under swamp conditions and in a puddled soil, yet no general system of cultivation holds good and neither can it be said that what is good for one district holds good for another. In one district, it is the general custom to plough the land in the dry season with excellent results; yet the same custom imported into another district leads to failure. Paddies which flourish in one delta or district do not do well when transferred to another place where the conditions are, to all intents and purposes, of a similar character. Green manuring is found to answer perfectly well in one place, yet in another it may practically inhibit the growth of the crop. These and the many other mutually opposed facts which can be adduced make it essential that the conditions governing the growth of paddy should be closely studied in order to obtain, if possible, some common basis capable of explaining them.

As a basis from which to approach the problem, the study of the soil gases was undertaken and these have continued for several years. The soil gases are found to consist mainly of varying proportion of nitrogen and methane with a smaller proportion of carbon dioxide. Hydrogen is generally absent but as much as 11 per cent. has been noted and the amount of oxygen present is usually only a trace and was never found to be more than 3½ per cent.; the soil conditions are consequently quite anaerobic in character, denitrification is intense and consequently the most suitable nitrogenous manures are those containing ammonia or those which, under the conditions, can yield ammonia or analogous compounds.

A prominent feature of the case is, that the conditions become anaerobic in character immediately water is admitted to the field and consequently all nitrates produced during the dry season when the soil is deeply cracked and air has free access to all parts, are quickly destroyed and have little effect on the growth of the crop which is put in some time after the first puddling. On the same basis, neither can the good effect of dry ploughing as is customary in Malabar be put down to the nitrification induced but on the other hand, the failure of this system, when imported into other districts can be ascribed in some measure to the reduction of nitrate to the poisonous nitrites.

A further and most surpassing fact brought out was, that the composition of the gas is dependent upon the presence or absence of the crop. Before the crop is put in the land, the soil gas consists of about 60 per cent. methane and 30 per cent. nitrogen. Whereas, within about 30 days from the time of transplanting this proportion is entirely reversed. That this is due to the presence of the crop is shown by analysing the gases from the cropped and uncropped plots when in the latter case, methane greatly preponderates throughout the period of experiment; whereas in the cropped plot nitrogen is present in the greatest proportion. So far as the measurements go, the volume of gas in the cropped plot is not less than that in the uncropped plot and consequently the crop either brings about a reduction of the amount of crabon converted into gaseous products or leads to a liberation of nitrogen. The mechanism of this change can of course be due to one or all of several causes which are under further investigation, but recent results with pot experiments show that the possibility of carbon assimilation by the roots must not be left out of account.

The fact that the soil gases of cropped areas consist so largely of nitrogen made it desirable to discover its source. It can come from (1) air imprisoned in the soil, (2) the nitrogen dissolved in the irrigation water and (3) from the soil organic matter and the manure used. Comparisons between manured and unmanured fields gave results pointing to the last mentioned being the source and these observations have since been confirmed in the pot-culture house. Consequently there is, annually, a large loss of nitrogen occurring in paddy fields and investigations having as their object the mitigation of this loss are in hand.

So far, the gases actually in the soil only have been considered but the matter is complicated by the fact that the gases actually evolved from the surface of the soil and which can be collected in inverted funnels consist of a approximately equal parts of oxygen and nitrogen with no trace of carbon dioxide or methane or hydrogen. In other words, in normal conditions,no carbon escapes from these soils in gaseous combinations. The source of this evolved gas was traced to a thin layer of organized growth formed over the whole surface of the soil and which varies in character in different localities. That it is the source of the gas is easily demonstrated by the use of weak copper sulphate solution of such a strength as not to kill the crop, when the evolution of the oxygen immediately ceases and in its place a much smaller volume of the soil gas is obtained. In the finest examples of this film the bubbles of oxygen and nitrogen are imprisoned between it and the soil so that there is a highly oxyginated atmosphere in contact with the latter. Even when the film is not so apparent, the surface of the soil is covered with minute bubbles of the gas and consequently the water at the soil surface and just within the soil is very highly charged with oxygen. The paddy root—at least those portions capable of taking up water—is devoid of air spaces, such as are found in water roots and consequently it requires oxygen from the surrounding water and therefore the probability of the film in bringing about aeration was studied. Measurements of the gases evolved from cropped and uncropped pots, under varying conditions, always show that less oxygen is disengaged by the former than from the latter, although they evolved approximately the same when both pots were without crop, thus directly demonstrating the absorption of this oxygen by the crop.

In the experiments just quoted, the importance of drainage was first made apparent. It was found that the root development in the pots which had drainage was deep; whereas in the undrained pots the roots merely formed a thick mat at the surface of the soil and did not extend to any great depth and at the same time the cropping was much heavier in the former. This is explainable in the light of the method of aeration of the roots, for in the case of the undrained pots, the aerated water is near the surface of the soil and there the roots naturally go, whereas, in the drained pots, the aerated water passes downwards into the soil allowing the roots to penetrate deeper. The more extended root action will obviously be of great value to the plant. Field observations support this, for whenever fields have been trenched deeply, as for surgarcane and betel vine cultivation, and the trenches subsequently filled in, then the drainage is improved and a corresponding better stand of paddy is obtained.

Direct experiments on the effect of drainage on the crop show that a small amount of drainage will greatly improve the yields but that much drainage is very detrimental and prevents the formation of the aerating film and decreased yields result. The effect of too much drainage on the paddy crop is seen in the Periyar Delta.

It was expected that, as paddy roots require aeration, the draining off of the water at intervals and allowing the air to penetrate the soil would be beneficial to the growth of the crop. The results were very disappointing, the best ones showing very little increase over the unaerated pots and all were very inferior to the yields produced by drainage alone. This shows that the oxygen required for aeration must be in solution, and furthermore the importance of the surface film was demonstrated as the draining and surface drying prevented its formation and the consequent aeration of the roots.

This question of aeration combined with drainage throws a vivid light on the behaviour of varieties of paddy when transplanted to foreign districts. The different paddies are usually confined to circumscribed districts and have been evolved *in course of time* with characteristics suited to the local soil conditions and it is quite possible that when introduced into other districts where the drainage is different that the aeration is unsuitable and the crop deteriorates.

During the course of these experiments, the peculiar effect of green-manuring in badly drained soils was made very apparent. Undrained manured pots gave less yields than the corresponding unmanured pots, whereas when drainage was introduced, the reverse result was obtained. Here the conclusions arrived at point to this being due to the toxic products of decomposition not being removed from the area of root development in the case of the undrained pots. Consequently the introduction of green-manuring into areas of badly drained paddy land must be undertaken with extreme caution.

In making the measurements of the oxygen and nitrogen evolved from cropped and uncropped pots, it was found that less nitrogen (as well as oxygen) was evolved from the former. On plotting out the differences, it was apparent that the absorption (using the word in a loose sense only) of these gases took place in two stages, namely, the quick growing period and the period of filling the grains and that in the intermediate stage no absorption took place. This points to the conclusion that the *nutrition of paddy takes place in two stages and combined with the fact that* in a few parts of Madras it is the custom to manure at half growth makes it desirable to investigate the best time of applying manure.

Bacteriological investigations have gone hand in hand with these experiments and several observations of interest have been made. They are not, however, in a stage advanced enough to permit of general conclusions being drawn.

The following general conclusions have been arrived at with regard to swamp paddy cultivations :—

1. Paddy soils under swamp conditions are anaerobic in character and the fermentation of the manure leads to a large loss of nitrogen.
2. The function of the surface film is to aerate the paddy root and that drainage increases the area of aeration thus producing a more extended root action and better cropping.
3. The rate of drainage required to produce the best results is comparatively slow. Too much drainage is detrimental.
4. Alternate irrigation and drying off is detrimental if the surface of the soil is allowed to become dry.
5. Green-manuring is only suited for land having drainage. In undrained land it reduces the yield.

The above investigations are being prepared for publication in detail as a departmental Memoir and will probably be available at the time the Conference sits.

(Mr. T. Bainbrigge-Fletcher.)

INSECT PESTS OF PADDY IN SOUTHERN INDIA.

Orthoptera (Grasshoppers).

1.—*Hieroglyphus banian*, Fb.

This grasshopper occurs throughout the plains of Southern India in all rice-growing tracts. The eggs are laid in masses in the ground, often in bunds of paddy-fields, usually between October and December, the young emerging about June, soon after the South-West Monsoon rains have started. The young hoppers are brownish-yellow, with a yellowish stripe *down the middle of the thorax, and do not usually assume a greenish colour until they are about to* acquire wings. The hoppers live and grow for about 70 days in the case of males, or 80 days in the case of females, before reaching the adult winged state.

This insect feeds on paddy, sugarcane and maize, but chiefly on paddy of which crop it is a major pest, doing serious damage both in the adult and hopper stages.

The best remedial measure seems to be the catching in small bag-nets of the young hoppers soon after they have hatched out and before they have had time to do serious damage.

2.—*Oxya-velox*, Fb.

This grasshopper is smaller than *H. banian*, more slenderly built and with the upper pair of wings reddish in colour. Its life history is not known in detail. It feeds on paddy, *cholum*, sugarcane, etc., and is usually a minor pest of paddy, sometimes doing appreciable damage. It is often found in company with *H. banian*, and may be controlled in the same manner, *i.e.*, by sweeping in bag-nets. The adult grasshopper is sometimes attracted to lights at night and trial of light traps is indicated in cases where damage is being done.

COLEOPTERA (BEETLES).

3.—*Epicauta*, Sp.

This is a small Cantharid Beetle with drak-brown wing-covers bearing a longitudinal cream-coloured stripe. It has been found as a local pest of paddy in South Kanara in October, eating the flowers and also attacking ripe ear-heads. The life-history is not known. Collection of the beetles by the hand or in small handnets is indicated as a means of control.

4.—*Oides affinis*, Jac.

This beetle has been found at *Shoranur* (Malabar) in July and August. Its status as a pest is doubtful; at most it seems sporadic and local.

5.—*Leptispa pygmæa*, Baly.

This minute, narrow, steel-blue or dark green beetle is found chiefly in South Kanara, Malabar, Mysore and Cochin, usually in July and August. The eggs are laid on paddy leaves and the grubs also feed on the upper surface of the leaves, the attacked leaves usually folding over so as to hide the enclosed grub, which, when full-fed, pupates on the leaf, the beetle emerging after about four days. Sometimes as many as five grubs may be present on a single leaf, eating out longitudinal patches. The beetles also eat the leaves but to a less extent. This insect may be a serious pest, said to be worst in wet weather.

No successful remedy has been devised so far, but bagging by handnets may be tried.

6.—*Hispa aenescens*, Baly.

This small, blue-black, spiny beetle occurs in all the rice-growing tracts of Southern India and becomes sporadically a serious pest of paddy. The eggs are laid on the leaves in which the grubs tunnel, producing discoloured patches, and ultimately pupate in the leaf. No satisfactory remedy has been found so far, but bagging of the beetles in nets may be suggested.

7.—*Calandra oryzae*, L.

The Rice-weevil is occasionally found in the field on the ripe ear-heads, but can scarcely be considered a pest of paddy, although of course it is a serious pest of stored rice.

LEPIDOPTERA (Butterflies and Moths.)

8.—*Melanitis ismene*, Cram.

This butterfly is found throughout Southern India occurring from sea-level to elevations above 7,000 feet. Eggs on leaves of grasses. Caterpillar pale-green with a roughened skin, the head darker and bearing a pair of horn-like processes, and with the anal extremity produced into two slender processes; it feeds chiefly at night, remaining motionless during day time. The stout, smooth, pale-green pupa is slung by the tail from a grass-stem or leaf. The caterpillar sometimes attacks paddy but does very little damage as a rule.

9.—*Parnara mathias*, Fb.

The Rice-skipper occurs throughout the plains of Southern India but is a minor pest of paddy as a rule, its number being kept in check by various parasites and predators. The caterpillar lives in leaves rolled longitudinally and is pale-greenish with a whitish line along the side and indistinct pale creamy bars across the back. Pupa pale greenish, attached to a leaf.

10.—*Parnara colaca*, Moore.

This skipper, rather similar in appearance to *P. mathias*, has been found on paddy at Saidapet and Madras, but can scarcely be considered a regular pest.

11.—*Telicota augias*, L.

This skipper whose wings are tawny-yellow marked with black, is a minor pest of sugarcane as a rule, but is also stated to feed on bamboo and paddy. It has not been noted as doing any real damage.

12.—*Cirphis anipuncta*, Haw.

The Army worm occurs throughout Southern India, usually appearing in any numbers in October and November The caterpillar is a minor pest of *Cholum*, occasionally attacking paddy, maize, etc. Protection of cultivated tracts, by digging narrow steep-sided trenches around them, is usually the only practical measure to prevent attack when the caterpillars are swarming.

13.—*Spodoptera mauritia*, Boisd.

This moth occurs throughout Southern India and the caterpillar sometimes does considerable damage to seedling rice-plants. The eggs are laid, usually on the under-surface of blades of grass or paddy in batches covered by buff-coloured hairs derived from the female moth. The caterpillar is variable in colour, lighter or darker green, often with a row of black dashes along the side; it feeds by night, hiding during the day-time under clods, etc. When full-fed it pupates in the soil, the moth emerging after about ten days. In the case of small areas, such as seed-beds, the following control-measures may be adopted:—(*i*) Protection of seed-beds by surrounding them with narrow steep-sided trenches, (*ii*) Collection of egg-masses, (*iii*) Spraying, (*iv*) Flooding of area and turning in ducks. This last method is used successfully in some districts.

14.—*Sesmia inferens*, Wlk.

This moth occurs throughout Southern India, the caterpillar being a bad pest of *ragi* and often found as a minor pest of maize, *Cholum*, paddy, wheat and sugarcane. The caterpillar bores inside the stem, pupating in the larval burrow. The attacked plants show dry ear and destruction of these is indicated to prevent extension of the attack.

15.—*Remigia frugalis*, Fb.

This moth occurs throughout Southern India, and is occasionally a very minor pest of paddy. The greyish yellow semi-looping caterpillar feeds exposed on leaf-blades.

16.—*Psalis* (*Dasychira*) *securis*, Hb.

This occurs throughout the plains of Southern India and is a minor pest of paddy. The eggs are laid in batches covered with hairs. The full-grown caterpillar is about $1\frac{1}{4}$ inches long, rather stout, in colour bright yellow with a broad red-brown stripe down the back and a narrow paler stripe along the side; head dull orange; on either side of the head too long tufts of hair project forward and a single tuft backwards from the anal segment; down the middle of the back are four short, thick, rounded, brush like tufts of pale yellow hairs and behind these two bright red papules; all the segments with numerous warts from which arise spreading tufts of fine pale hairs. Pupation as a rule on a leaf-blade in a cocoon formed of silk interwoven with larval hairs; pupal period about ten days. The caterpillars are conspicuous and feed exposed and are therefore easily collected by hand.

17.—*Ancylolomia chrysographella*, Kollar.

This moth is found throughout Southern India, the caterpillar feeding on paddy, *Paspalum dilatatum*, and probably on all grasses. It has only been found on one occasion as a serious pest of paddy seedlings, but is, however, liable to occur at any time in dry, sandy localities.

The caterpillar is about an inch long, cylindrical, slender, smooth, with short prolegs; in colour pale green with a blackish head and plate on prothorax. It feeds at night, remaining during day in hiding underground in long tubular galleries lined with silk at the roots of the footplant. Pupation in larval gallery; pupal period about 10 days.

Control measures include (I) Flooding of affected areas to bring up the caterpillars which are greedily devoured by crows, etc., (II) spraying of plants (in small experimental areas, seed-beds, etc.), and (III) attraction of moths by means of light-traps at night.

18.—*Schoenobius bipunctifer*, Wlk.

The paddy stem-borer occurs throughout the plains of Southern India as a very serious pest of paddy.

The eggs are laid on leaves in clusters covered with yellowish hair derived from the anal tuft of the female moth. The caterpillar bores in the stems of paddy and perhaps of wild grasses also. The full grown caterpillar is about four-fifths of an inch long, slender, smooth, distinct segments; in colour dull whitish or yellowish sometimes with a green

tint; head orange-yellow. Pupation takes place in the larval burrow, which is lined with silk, and the moth emerges through a hole previously cut by the caterpillar through the side of the stem.

No really successful control-measure can be given as yet, but the following are indicated as means of reducing damage :—(I) Ploughing and, if possible, burning of paddy-stubble after the harvest is gathered, (II) collection of eggmasses which are conspicuous, (III) attraction of moths to light-traps at night.

19—*Nymphula depunctalis*, Gn.

This moth is a serious pest of paddy throughout Southern India sometimes causing great damage. The caterpillar is semi-aquatic, living in cases made of rolled pieces of leaf, and is furnished with bunches of slender filamentous gills along the sides; it is slender about three-fifths of an inch long; in colour pale green with an orange head. It crawls up the plant above water-level and feeds on the green tissues of the leaf. Pupation in the larval case.

Draining the water off the affected fields is indicated as a remedy but this is rarely practically possible as this pest is chiefly found in low-lying water-logged areas. In some districts a thorney bush is dragged over the field to dislodge the larval cases and the water is then drained off; it is, however, difficult to see what is the value of the thorney branch and the draining of the water is evidently the important factor where success is claimed for this method of treatment.

20.—*Cnaphalocrocis medinalis*, Gn.

This moth occurs throughout the plains of Southern India and is a minor pest of paddy as a rule, occasionally doing considerable damage in the Northern Circars. It is not known as a pest in the Southern parts of Madras.
The slender green caterpillar is about four-fifths of an inch long; it lives inside folded leaves, which are not actually rolled but the tip fastened over the broader basal part; it eats the leaf-tissue so that the leaves become whitened and sickly.

No remedial measures, applicable on a field scale, can be suggested at present.

THYSANOPTERA.

21.—*Thrips*, Spp.

Various species occur on paddy, but they have not been worked out and cannot be discriminated at present.

RHYNCHOTA (Bugs.).

22.—*Menida histrio*, Fb.

Found throughout Southern India as a minor pest of paddy. Also on wheat, *cholum*, and pulses. Life-history not known. Collection by handnets is indicated in the cases of small areas.

23.—*Tetroda histeroides*, Fb.

Has been found at Salem and Coimbatore as an occasional minor pest of paddy. Collection by hand and in handnets is indicated in the case of small areas.

24.—*Leptocorisa varicornis*, Fb.

The rice-bug occurs throughout Southern India as a serious pest of paddy especially on the West Coast.

The round flattened, dark-brown eggs are laid in rows on leaves of paddy and grasses. The young bugs are pale-green with long antennae; they suck the juices of their foodplant, but are little noticeable as they do not affect the exposed parts of the plant and readily drop to the ground when disturbed. The bugs especially attack the ripening grain, sucking the milky juice, so that the ears turn wholly or partly white, no grain being matured.

Collection in handnets has been found the most efficient method of control.

25.—*Tettigoniella spectra*, Dist.

This small white Jassid occurs throughout Southern India in paddy fields. It has not actually been noted to be a pest, but may at times do some damage. The adults are strongly attracted to light at night and this fact may be utilized as one means of control.

26.—*Nephotettix bipunctatus*, Fb.

This minute green Jassid occurs throughout the plains of Southern India on paddy and probably on various grasses also. It has not actually been noted to do damage but sometimes appears in such enormous numbers that it may be assumed to be at least a minor pest. The adults fly freely to light and this fact may be utilized if control-measures are required.

The foregoing insects may be tabulated as follows :—

Status.	Boring in stem.	Eating leaves.	Sucking juice of plant.	Other damage.
Major Pest, doing serious damage.	Schoenobius bipunctifer.	Hieroglyphus banian. Leptispa pygmaea. Hispa aenescens. Spodoptera mauritia. Nymphula depunctalis.	Leptocorisa varicornis.	
Minor Pest, of regular general occurrence.	Sesamia inferens .	Oxya velox. Melanitis ismene. Parnara mathias. Psalis securis. Cnaphalocrocis medinalis.	Menida histrio. Tettigoniella spectra. Nephotettix bipunctatus.	
Occasional Pests of little importance as a rule.	......	Oides affinis. Parnara colaca. Telicota augias. Cirphis unipuncta. Remigia frugalis. Ancylolomia chrysographella.	Tetroda histeroides .	Epicauta sp. Calandra oryzae. Thrips.

CENTRAL PROVINCES.

(THE DIRECTOR OF AGRICULTURE.)

On the Chemical side Mr. Plymen proposes to examine the more important Central Provinces varieties with a view to determine the distribution of the nitrogenous constituents in the grain.

2. On the Botanical side a full review of the past 5 years' work on the classification of Central Provinces rices is in preparation by the Economic Botanist and should be ready before the meeting of the Board of Agriculture in December next. *Six hundred and seventy rices have been received, pure cultures have been separated out, and the basis of* classification examined and defined.

3. On the Agricultural side the usual experiential series have been tried at the Tharsa and Raipur farms to determine the effect of varieties of manure and of differing seed rates, spacing between plants and water supply, as bearing on the general question of defining the best system of agriculture for rice. But the main work of the Department has been the *attempt to introduce superior* varieties of seed and superior methods of rice cultivation, especially those already accepted in one part of the Province but discredited elsewhere owing to local ignorance or prejudice. Thus the introduction of *transplantation in Chhattisgarh, where the general practice is broadcast sowing, is a matter that has absorbed a large* proportion of the Department's attention in recent years. Again, in areas where transplantation is well established, the advantages of *transplantation by single seedlings are gradually being taught. Then there is the problem of introducing* improved varieties or special varieties suited to special conditions. The advantage of growing the finer qualities for export is one not sufficiently appreciated. And besides this, the growth of heavy yielding coarse rices, and of rices which are not so brittle as to suffer from being polished before being put on the market, or are not fancied by pig or other wild animals, requires a good deal of pushing. The introduction of mechanical rice hullers should also be taken up soon, if these can be obtained at a reasonable price.

4. As regards the prevalence of fungi and insect pests, no more information seems to be available beyond what is stated by Mr. Evans, namely, that the crop as a whole is singularly *free from such attacks, but suffers from grass*hoppers and from stem borers occasionally.

(MR. R. G. ALLAN, OFFICIATING DEPUTY DIRECTOR OF AGRICULTURE, SOUTHERN CIRCLE.)

This circle contains the 3 divisions of Berar, Nagpur and Chhattisgarh. Rice forms the staple crop throughout the last named Division where it covers an area of on an average of 3,150,700 acres. In the Nagpur Division rice is also a crop of major importance, but chiefly so *in the more eastern districts of Balaghat and Bhandara* and to *the* south in Chanda. The acreage under rice in this Division is about 1,055,700 acres. The remainder of the circle is chiefly a cotton tract, and rice is only found in comparatively isolated areas. The chief centre of the Department's rice work is at Raipur, the centre of the Chhattisgarh Division. The Nagpur Division is provided with two farms at which rice is dealt with, *viz.*, Tharsa in the Nagpur District and Sindewahi in Chanda. Both these farms are, however, of much more recent origin than that at Raipur, and up to the present little experimental work has been attempted in them. The attention of the Department has been chiefly concentrated on Chhattisgarh.

The Chhattisgarh Division.—Cultivation is backward. Paddy is almost universally broadcasted in the fields and treated to a form of cultivation known as *Biasi*, by which when the plants have attained a height of one foot or 15 inches the plot is cross ploughed,—a process which partly thins and partly stimulates the surviving plants. Transplantation before the advent of the Agricultural Department was practically non-existent. But early work on the Raipur farm clearly demonstrated its great advantages. Though requiring more care and labour and delaying the date at which *the* crop can be cut, it was found that transplantation obtained for the cultivator a yield exceeding that given with *Biasi* by *from 500 to 600 lbs. per acre. Hence the chief work of the Department in this Division has been the furtherance of transplantation, especially in areas commanded* by *tanks where the possibility of irrigation permits* the safe growth of the later and heavier yielding rices. The benefits of transplantation may not be new, but the work of persuasion and demonstration to a class of cultivator intensely conservative and at the same *time lazy*, has called for considerable energy and organisation.

The following figures show a steady progress in the area transplanted which may soon be expected to expand more rapidly *as the assistance of district officers has now been invoked in preaching the benefits of the new method* :—

Year.	*Area transplanted.*
1906-07	20 acres.
1907-08	1,000 ,,
1908-09	3,500 ,,
1909-10	4,000 ,,
1910-11	6,000 ,,
1911-12	6,910 ,,
1912-13	15,470 ,,
1913-14	30,000 ,, (approximately).

The work is being conducted this year from 12 centres to which Agricultural Assistants have been posted. In addition to these some 48 *Kamdars* are employed, some in demonstration and others in co-operation with the Land Record Staff.

The chief lines of work then in this Division are the introduction of transplantation and higher grain-yielding varieties of paddy. For the latter purpose seed farms will be started at several centres this year. Improvement in the production, however, of local paddy has been sought by the introduction of varieties from other Provinces and districts and by a plant to plant selection of the better local types. Such breeding work, however, can be done more accurately and satisfactorily by the Economic Botanist, and the farm work in the future will be principally the trial of such types as he isolates and their comparison with those already existing. Quantity at present appears more necessary than *quality*.

Nagpur Division.—In the districts of this Division, rice cultivation is on a much higher plane—transplanting being far more common than in Chhattisgarh and at some centres universal. But transplantation is invariably made in bunches. As experiment has shown the value of single seedling transplantation, efforts are now in progress towards the spreading of this method in place of that mentioned above. There is every indication that the cultivators of this tract *will pick up this method rapidly. It is probable that quality will have to be taken into consideration in rice* breeding in these districts.

Miscellaneous problems.—Turning to other and more general problems which have been under examination at Raipur, we have problems relating to manuring, green-manuring, water rates, double cropping after rice, and spacing in transplantation.

In manuring, experiment has shown that rice benefits to the greatest extent when the soil is manured with such heavy organic manures, as poudrette and nightsoil or with organic fertilizers such as castor cake and bone dust.

Mineral fertilizers, cynamide, ammonium sulphate and nitrate of potash have given but poor results. The average results of different manures in recent years are stated below :—

Name of Manure.	Medium paddy grain unirrigated.	
	Biasi.	Transplanted.
Cattle dung 20 lbs. N.	1,070	1,374
Calcium Cyanamide 20 lbs. N.	654	971
Bone dust 20 lbs. N.	1,207	1,750
Bone dust 10 lbs. Nit. and Saltpetre 10 lbs. N.	892	1,511
Dried leaves 20 lbs. N.	586	952
Tank silt 640 maunds	889	1,177
Castor cake 20 lbs. N.	923	1,334
1 year old poudrette 20 lbs. Nitrogen	889	1,027
Night soil (Meagher system) once in three years	1,104	2,071
Bone dust 10 lbs. Nitrogen and ammonium sulphate 10 lbs. Nitrogen	556	1,052
Unmanured	277	514

Green manuring has been found to be effective and profitable. The two main crops used have been *san* and *sawri*. *San is the quicker growing and in that respect more effective; but sawri is less affected by water-logging, which is apt* to occur if *san* is sown in the monsoon. At Tharsa *san* has been sown before the rains with light irrigation and has grown well.

Double cropping is common on the heavier soils throughout Chhattisgarh; linseed, *urid*, *teora* and gram are the common crops used. The system usually adopted is that locally termed *Utera*, which consists in broadcasting the 2nd crop while the first is still standing. Enquiry has been in progress as to whether this or drilling after the harvesting of the first crop is the better. The results up to date, however, are inconclusive, but point to an advantage in favour of drilling if water is available for cold weather irrigation. The growth of a cold weather legume benefits the next year's growth of paddy.

The problems of water rates for irrigated paddy have not yet received sufficient study to call for any remarks.

Implements.—Meston and other light ploughs are becoming popular. An effective small power and reasonably cheap huller would find a market.

(Mr. G. Evans, Deputy Director of Agriculture, Northern Circle.)

This crop is not one of great importance in the ten Northern Districts of the Central Provinces, but there are several tracts of country where it may almost be considered a staple.

Of these the south-east portion of Seoni district, with Burghat as the centre, is a famous rice tract comprising about 80,000 acres annually under this crop. The cultivators are largely *Powars* and the cultivation methods are good. *The fields are well embanked and transplantation is almost invariably practised* and the general methods compare favourably with those of the adjoining Wainganga tract. In this tract the problems resolve themselves into—

(1) The saving of seed by transplantation of single seedlings instead of planting several young plants as is done at present.

(2) Where irrigation is available the introduction of heavier yielding varieties.

(3) The introduction of varieties of better quality, as in addition to being consumed locally large *quantities of* rice are exported to neighbouring tracts and 'quality' is a factor that is appreciated and is recognized by enhanced rates in local markets.

In parts of the Mandla district also rice is an important crop; but as markets for the disposal of surplus produce are not so accessible, quality is not of so much importance and heavier yielding varieties are at present being sought for.

Another considerable rice tract is that which extends through the *southern* part of Damoh into the two northern Tehsils of the Jubbulpur district, representing an average area of 55,000 and 1,20,000 acres of rice respectively, cultivated annually.

Here the rice is grown on land which is not specially suited for Rabi crops and the cultivation owing to uncertain rainfall and the lack of proper embankments and irrigation, is precarious. So that the tract owing to the partial failure of the rice crop suffers from periods of scarcity.

Since the 1900 famine, however, the Irrigation Department has constructed a number of tanks and rendered other sources of irrigation available, so that the problem naturally resolves itself into two parts—

(1) In the areas commanded by irrigation which are comparatively few in number, transplanting of heavier and bigger yielding varieties is being taught on the yellow soils. While on the black and mixed soils double cropping is encouraged, an early ripening rice being followed by a pulse crop or a mixture of wheat and gram.

(2) In the far larger area unprotected by irrigation, heavy yielding early varieties are being introduced, and *transplantation is not attempted as this process tends to delay the time of ripening.* The local 'machowa' method is found more suitable.

The idea is to go for safety and ensure as far as possible a crop every year.

The varieties grown in this tract at present are all of coarse quality and in the neighbourhood of good markets an attempt to introduce varieties of better quality is being made.

In other districts small and scattered rice tracts occur; and localities are also found in which conditions seem suited for early rice, but where, owing to the backwardness and ignorance of the people, the inferior millets such as *Kodon* and *Kutki* only are grown.

Demonstration Farms for rice either have been or are being opened at two places in each of the Jubbulpore, Mandla and Seoni districts at present; and more will be opened to tackle the different problems of the various tracts as trained staff becomes available.

With regard to implements a really efficient hand or bullock power rice-huller is needed and could, I think, be readily introduced if the price was not too high. Merton and other light ploughs are rapidly becoming popular.

With regard to manures, green-manuring with *san*-hemp has given good results in the advanced Burghat tract where the rainfall is heavy and irrigation is available.

As regards actual diseases and pests a species of stem borer does damage if the crop is kept flooded at the time the flowers have appeared; and grasshoppers sometimes do a certain amount of damage. But the crop as a whole is singularly free from pests; and birds and wild animals do more damage in an average year than all of them put together.

ASSAM.

(Mr. A. G. Birt, Deputy Director of Agriculture.)

Rice is the most important crop in Assam, the average annual area being a little over 4½ millon acres. Winter paddy accounts for about 3¼ million acres. *Aus* paddy for about 800,000 acres, and *Boro* paddy for about 200,000 acres.

Winter paddy.—Under this head is included all paddy harvested from the end of October to the beginning of January. This constitutes the main crop. It can be divided into:—

(*a*) broadcasted;

(*b*) transplanted.

No figures showing the proportion of transplanted to broadcasted are available, but as a rule paddy is broadcasted on land which goes under more than about a foot of water during the rains and transplanted on higher land where the water can be controlled. In the Assam Valley districts, therefore, where the bulk of the paddy land is above flood level, the crop is transplanted; but in Sylhet where there are large heavily flooded tracts, a large portion of the crop is broadcasted. In the Upper Assam Valley, most of the cultivation is "Ek Fasl," *i.e.*, only one crop of paddy is taken from the same land in a year. In Sylhet, however, an *Aus* paddy crop or in rare cases a jute crop precedes the transplanted paddy crop, and this is known as "Do-Fasl" cultivation.

Broadcasted winter paddy is grown in the plains on land which goes under from 1 to 10 feet of water, and is the only crop grown on such land which is therefore known as "Ek-Fasl." The land is prepared in March and April when the spring rains have softened the surface of the land, and the seed is broadcasted in April. Sometimes a mixture of *Aus* and *Aman* paddy is sown, the *Aus* being harvested and separated in July and the *Aman* allowed to remain until the autumn, but this is more common in the South-East districts of Bengal than in Assam. The crop is rarely manured, but I have heard of water weeds being collected from the *bheels* for this purpose. The crop is sown dry, but as the rainy season advances the water level gradually rises and covers the fields to a depth of sometimes as much as 10 to 12 feet. The growth of the paddy keeps pace with the rise of water, and consequently straw 12 feet in length is not uncommon. The paddy is ripe from end of October-December, and by that time the water has usually subsided sufficiently to allow harvesting operations to be carried out. Only the head of the paddy with about 12 inches of straw is cut, the remainder of the straw being left on the field where it is subsequently grazed by cattle during the cold weather.

For the purposes of crop forecasts the normal yield of all winter paddy is taken as 12½ maunds of cleaned rice per acre, which is equivalent to about 20 maunds of *dhan* per acre, but in a good season yields of from 25 to 30 maunds of *dhan* per acre are not uncommon.

In the hill tracts broadcasted winter paddy is grown under wet cultivation in valleys and in terraces on the slopes. Here the water supply is usually under control, the water being let into the fields in April, the land puddled, and the seed broadcasted on the puddle in May. In some parts of lower hills transplanting is done, but the usual practice is to broadcast.

Transplanted winter paddy is grown on moderately high land where the water conditions can be controlled. In the Upper Assam Valley districts it is practically the only crop taken. The preparation of the land is in progress from April until August, but the Upper Assam cultivator is generally in no hurry to commence work and so long as he gets his paddy in by August he is usually content. After two or three preliminary ploughings the land is puddled in July-August when there are two or three inches of water on the fields. The paddy seedbeds are usually located on higher land. The seed rate of paddy sown in the seed-bed is generally about 2 maunds per bigha (1 bigha = ⅓ acre) and a bigha of seed-bed will provide sufficient seedlings for from 10 to 20 bighas of transplanted paddy. The number of seedlings transplanted in a bunch and the distance at which transplanted, varies considerably with locality and time of planting. Speaking generally, in the Upper Assam Valley, planting is done wider apart than in Sylhet, and in both tracts the earlier the time of planting the greater the distance and the fewer seedlings in a bunch. For example, in early July seedlings are transplanted in bunches of two or three at distances of from 12" to 18" apart, while at the end of August the number of seedlings in a bunch would be increased to five or six, and the distance reduced to about 8 or 9 inches.

In Sylhet, where a crop of *Aus* paddy is usually taken first, the land is puddled and the paddy transplanted in July immediately after the *Aus* paddy has been harvested. Manuring of paddy in the Upper Assam Valley is uncommon, but in Sylhet and some of the lower Assam Valley districts where the transplanted crop is preceded by *Aus*, cowdung is applied before sowing the *Aus*. The quantity depends upon how much the cultivator can spare after keeping sufficient for his vegetable garden, paddy seed-beds, and perhaps a small patch of sugarcane, but probably about 75 maunds per acre would be somewhere near the mark.

The bulk of the transplanted winter paddy crop is harvested in November and December, about a foot or more of straw being usually left standing in the field. Sometimes this is cut subsequently and taken home for fodder, but usually it is grazed off by cattle on the field.

A good crop of transplanted paddy from "Ek-Fasl" land would be from 25 to 30 maunds per acre, and from "Do-Fasl" land from 20 to 25 maunds per acre.

Aus paddy.—This is an early variety of rice grown usually under dry land cultivation, although occasionally in Sylhet it is transplanted in puddle like winter rice. About half the total area under this crop is returned by the Surma Valley, while the Surma Valley *plus* Kamrup and Goalpara account for about three-fourths of the total area.

The crop is sown broadcast in April and the early part of May, and is usually followed in July or August by a crop of transplanted winter paddy. Sometimes, however, it is followed by a *rabi* crop (rape or pulse) instead. The grain is generally coarser than that of transplanted winter paddy and is not so valuable. The yield also is lower than that of winter paddy, from 15 to 18 maunds per acre being regarded as a fair crop. The normal yield taken for the purpose of forecasts is 14 maunds per acre.

In the hill tracts *Aus* paddy is sown on *Jhums* either as a pure crop or mixed with cotton, *til*, etc. *Jhums* are prepared by felling the jungle and burning it *in situ*. The only implement used is the "dao" with which the seeds are dibbled in the burnt surface.

No manure is ever used in "Jhum" cultivation and the "Jhum" is abandoned after two or at the most three years.

Boro paddy or spring rice.—This is grown on the sides of *bheels* and other low places in Sylhet where the water is too deep even for long stemmed *Aman* paddy in the rains, but where the water recedes as the floods subside in the beginning of the cold weather, leaving long stretches of damp mud.

The cultivation is similar to that of transplanted winter paddy. The seed is sown in seedbeds in October-November; meanwhile the fields are prepared by making "ails" and puddling. The seedlings are transplanted from the latter

part of November to the first week in January. As the land on which the crop is grown is heavily silted by the floods, no manuring is necessary. The crop is harvested in March and April before the floods rise. The average outturn taken for purpose of crop forecasts is 20 maunds of *dhan* per acre which is the same as that for winter paddy.

Sylhet is the only district in the Province which returns an area under *Boro* paddy.

Insect pests and fungus diseases.—Since the reconstitution of Assam as a separate Province no complaints have been received of damage to paddy by insects or fungi; we may, therefore, conclude that last season the crop in this province was exceptionally free from these pests. With regard to former years I have examined such records as we have in the office and find that reports of insects damaging paddy in 1909, 1910 and 1911 were received from the following places:—

1909	North Lakhimpur	Stem borers.
1910	Karimganj, Sylhet	" "
"	Maulvibazar, "	" "
"	Tezpur, Darrang	Semi-aquatic rice caterpillar.
"	Barlekha, Sylhet	Stem borers.
"	Khasi Hills	Paintaphib.
"	Gauripur, Goalpara	Crickets.
1911	Sylhet	Stem borers.
"	Habiganj, Sylhet	" "

The Entomological Collector, Eastern Bengal and Assam, was in each case sent to the spot to investigate. For stem borers he advised burning the stubble and ploughing up the land immediately afterwards with the object of distroying the hibernating larvæ and pupæ; and for the semi-acquatic rice caterpillar he advised letting the water out of the fields. He identified the "Paintaphib" (local name) pest of the Khasi Hills as "Phryganeidal Neuroptera," a fly, the larva of which is contained in a hard shell-like case. For this pest he advised letting the water out of the fields, and also light traps to distory the mature insects.

As to what extent and with what success the cultivators applied these preventive and remedial measures I am unable to say, not being in charge of this portion of the Province at the time.

With regard to diseases caused by fungi the only record traceable is of a disease called "Khardhara" reported from the Goalpara district. The cause of this disease is rather obscure and is variously ascribed to a fungus and to "accumulation of organic acids in the soil." From the records which I have been able to consult it appears to be very similar to the "Ufra" disease now being investigated in South-East Bengal. It is recorded that one Babu Lalit Mohan Dutt of Dhubri used a dressing of "Hide salt" with great success on some paddy affected with this disease in 1910.

The above account is very incomplete, but owing to the disruption of the Agricultural Department of Eastern Bengal and Assam last year the records are difficult to trace.

At present we have no Entomological assistant in Assam, but a man is under training at Pusa, and if suitable, will be appointed to the post next November. One of his first duties will be to make a survey of the insect pests of the paddy crop.

Operations for the improvement of paddy cultivation.—Manurial experiments were carried out at Dacca by the Eastern Bengal and Assam Agricultural Department which proved raw bonemeal to be a very valuable manure for transplanted winter paddy, and demonstrations were forthwith carried out on cultivators' holdings with good results in 1911 and 1912. In 1909, the Economic Botanist, Eastern Bengal and Assam commenced a survey of varieties of *Aus* and winter paddy in Eastern Bengal and Assam, with the object of isolating superior varieties. This work is being carried out at Dacca Farm which has now no connection with Assam. However it is hoped that the results of the Economic Botanist's work will be of use in Assam.

Up to the present time very little work on rice has been done in Assam proper owing to the lack of a suitable experiment station. This want, however, will be supplied this year with the opening of an experiment station in Sylhet district.

In 1908 bonemeal as a manure for paddy was tried in serveral centres in the Khasi and Jaintia Hills district with such success that annually since then demonstrations have been carried out on cultivators' holdings throughout the district. As a result of these demonstrations the demand for bonemeal is increasing rapidly, and this year we have made arrangements for a supply of 15 tons for sale to cultivators in this district. The hill cultivators are so convinced of the efficacy of bonemeal that they are even willing to pay "fancy" prices for it, the price delivered to the Depôt at Jowai this year being R5-2 per maund. In order to obviate the heavy freight charges from Calcutta to the hills we are about to erect a small bonecrushing plant at Shillong, and next year we hope to supply bonemeal at about R3 per maund on the spot. It is anticipated that when the price is reduced the demand will be greatly increased.

Very little has been done with rice hitherto in the plains of Assam, but this year, on the strength of the results obtained at Dacca, where the condition of the soil is very similar to that in Assam, both soils being very deficient in phosphates, we have commenced a series of manurial trials in the districts of Sylhet, Kamrup and Sibsagar, representing the Surma Valley, Lower Assam Valley and Upper Assam Valley, respectively. The trials are being carried out at ten centres in each district, there being five plots, each approximately one *bigha* in area in each centre. One plot receives a dressing of three maunds of bonemeal per acre and another three maunds of flour phosphate per acre, the other three plots being controls. The flour phosphate is a raw mineral phosphate containing about the same amount of tricalcic phosphate as raw bonemeal. In Kamrup and Sylhet the trials are being made on "Do Fasl" land, *i.e.*, land annually carrying a crop of *Aus* followed by transplanted winter paddy; and in Sibsagar on "Ek Fasl" land, since the usual practice there is to take only one crop.

A similar series of trials is also being made this year in the Khasi and Jaintia Hills, in order to test the value of flour phosphate as against bonemeal. Should the supply of bones be insufficient to meet the increasing demand, we shall be able to fall back on flour phosphate, provided the results are satisfactory.

With regard to future work.—*(a)* A survey of varieties of all classes of paddy, *Aus, Aman, Sail* and *Boro* should be made tract by tract, as a basis for improvement by selection and possibly crossbreeding.

(b) Manurial experiment should be carried out to determine the most economical method of manuring *Aus*, and transplanted paddy especially; (broadcasted *Aman* and *Boro* being grown on heavily flooded tracts, manuring is of minor importance to improvement of varieties).

(c) The whole question of the most economical number of seedlings transplanted per unit area requires to be worked out, and in connection with this the effect of early and late transplanting and the seed rate in the seed bed on the tillering and producing power of the seedlings should be studied.

(d) Preparation of the land for transplanted winter paddy by puddling should be investigated with regard to the effect on the succeeding dry land crop on "Do Fasl" land. In this connection also the degree of puddle to which the land should be brought to obtain the best results with transplanted paddy should be considered.

On "Ek Fasl" land which carries one crop of transplanted winter paddy, the effect of early *versus* late preliminary ploughing requires to be worked out.

(e) The possibilities of rotating winter paddy with jute or *Aus* paddy in the same year on some of the higher land in Upper Assam where the water is under control and where now only one crop of transplanted paddy is taken, should be considered.

(f) Finally, the whole question of the nutrition of wet land paddy requires investigation. If this were thoroughly threshed out, it would probably settle a good many doubtful points with regard to cultivation and manuring.

Of the above six heads "a" will be taken up in two districts by District Agricultural Officers who will be appointed shortly. A complete survey will have to be postponed until the appointment of an Economic Botanist for the province; meanwhile a collection of varieties will be made on the new Experiment Station in Sylhet as a basis for further work. We shall probably be able to obtain assistance from the Economic Botanist, Bengal, in this work; "b" "c" and "d" will be taken up and an attempt will be made to work them out on the new Experiment Station in Sylhet. "e" will be kept in mind pending the appointment of a District Agricultural Officer to one of the Upper Assam Valley Districts "f" is a problem which might suitably be taken up by the Imperial Department. It is certainly at present beyond the scope of the Provincial Department.

BURMA.

(The Director of Agriculture.)

I have the honour to forward a statement of the problems in connection with rice which are being investigated by the Agricultural Department of this Province.

Agricultural.

(1) Experiments are being conducted both at Hmawbi and Mandalay to test the effect of certain artificial and green manures, as also that of drainage and of different methods of cultivation.

(2) Sowing and transplanting experiments for the purpose of discovering the most economical methods are also in progress at both stations.

(3) A study of machinery in connection with the crop is in progress at Mandalay and will be commenced at Hmawbi as soon as the buildings have been erected.

Botanical.

(1) Surveys of the principal varieties of paddies grown in both parts of the Province have been begun at both stations. The object is to obtain from the districts and maintain in pure cultures a collection of all the rices in the Province that seem most suitable for the present requirements of the rice industry. A considerable number of varieties received last year from Japan, Java and Siam are also included in the list, but most of the latter belong to types unsuited for the Burma trade.

(2) Intra-varietal selection is being carried on at both stations for uniformity of grain colour, form and yield. At Hmawbi six principal types were chosen last year and about 100 single ear cultures were isolated from each. These are being grown in separate rows during the present year and selection for yield will be made from the heaviest yielding rows. The selection will be made from year to year and will form a permanent part of the routine work of the station.

(3) As a precautionary measure to ensure purity of cultures cross-pollination tests have been devised at both stations. Last year's tests at Hmawbi had special reference to grain colour. Red coloration of the husked grain is one of the most serious defects of Burma rice and its continuance in the crop has been found to depend to some extent on the inability of cultivators to reject grains which have arisen from flowers cross-pollinated in the year of selection. From last year's results the amount of cross-pollination would appear to be less than 5 per cent. but a continuance of the work is necessary to obtain more reliable mean figures.

Chemical.

The work on rice carried out by the Agricultural Chemist embraces—

(1) Pot and plot cultures at Mandalay.

(2) Plot cultures at 6 outstations (including Hmawbi).

(3) Analysis of crops.

The questions under investigation may be summarised as follows:—

The effect of manures, soils, watering and climate upon the ripening yield quality, composition and productivity of some paddy varieties.

The questions of yield and of varietal distinctions are only considered in a few cases.

The work is not yet sufficiently advanced to permit differentiation between more important and less important questions.

Insect and fungus pests.

Insect attack in Lower Burma is of three kinds.

(1) Sucking insects attack the grains when the ear is emerging from the sheathing leaf. This is not of much importance.

(2) Caterpillars ring the stem either wholly or partly rendering the ear either wholly or partly sterile. This attack known locally as "gwa-bo" is often serious and is being investigated at both stations.

(3) Occasionally a large caterpillar bores up the stem. This usually ends in the death of the plant but it is not so common as "gwa-bo."

There are no fungus diseases of importance or which cause serious loss. Some Tilletia were found by Dr. Butler last year.

I.

Statement showing the area in acres under rice during the years 1902-03 to 1911-12.

	Province.	1902-03.	1903-04.	1904-05.	1905-06.	1906-07.	1907-08.	1908-09.	1909-10.	1910-11.	1911-12.
1	Bengal	37,898,929	35,770,948	36,921,157	38,338,100	37,239,181	20,053,500	19,725,800	21,078,870	20,969,438	20,960,900
2	Bihar and Orissa						16,882,800	14,586,900	17,887,900	17,752,100	17,365,000
3	United Provinces	6,980,542	6,038,543	7,084,314	7,078,563	7,726,690	6,966,654	5,892,018	6,120,518	6,034,108	5,274,748
4	Punjab	605,895	687,626	573,727	198,062	726,688	695,837	720,476	799,094	712,943	318,731
5	North-West Frontier Province	25,586	32,789	28,368	29,647	29,957	29,240	44,654	40,774	42,598	47,181
6	Bombay	2,228,582	2,447,711	2,339,922	2,526,163	2,669,521	2,694,450	2,755,755	2,960,622	2,993,868	2,770,690
7	Central Provinces and Berar	3,752,388	3,621,651	4,047,839	4,206,887	4,287,858	4,498,633	4,543,854	4,837,802	4,728,362	4,821,921
8	Madras	7,734,785	8,278,529	7,221,603	7,531,611	8,043,383	10,613,906	10,304,685	10,759,209	10,781,336	10,289,461
9	Coorg	80,694	79,763	79,111	79,172	79,617	81,121	81,149	81,792	82,502	82,527
10	Ajmer-Merwara	170	553	275	171	249	648	1,098	1,266	425	189
11	Pergana Manpur, Central India	54	69	89	98	88	92	59	85	88	137
12	Assam	3,998,001	3,960,020	3,963,880	3,803,253	3,430,813	4,062,849	1,345,736	4,492,507	4,406,156	4,616,197
13	Burma	8,333,020	8,678,502	9,265,097	9,283,801	9,307,078	9,400,952	9,798,353	10,050,203	10,020,557	9,894,261
	TOTAL	71,633,546	69,596,654	73,525,388	73,400,528	78,541,118	75,980,682	72,800,536	78,780,642	78,524,391	76,636,867

II.

Statement showing the proportion of the rice area to the cultivated area and the total area of the provinces during 1902-03 to 1911-12.

Year.	(By professional survey.) Total area in acres.	Cultivated area in acres.	Area under rice in acres.	Percentage of rice area to cultivated area.	Percentage of rice area to total area.	REMARKS.
1	2	3	4	5	6	7
			BENGAL.			
1902-03	100,192,331	51,361,727	37,893,929	73·7	37·8	These figures include the area which now forms the province of Biha- and Orissa.
1903-04	100,277,749	60,135,808	35,770,948	71·3	35·6	
1904-05	100,410,013	52,668,188	38,921,157	73·8	38·7	
1905-06 . . .	99,847,126	52,231,746	38,338,100	73·3	38·3	
1906-07	99,250,645	51,006,433	37,239,181	73·0	37·5	
1907-08	47,378,382	24,492,500	20,053,500	81·8	42·3	
1908-09 . . .	49,568,682	23,835,248	19,725,800	82·7	39·7	
1909-10	49,567,713	24,918,140	21,076,870	84·5	42·5	
1910-11	49,646,444	24,559,778	20,969,436	85·3	42·2	
1911-12	49,646,444	24,931,100	20,960,900	84·0	42·2	
			BIHAH AND ORISSA.			
1902-03 to 1906-07	...	...	...	...	...	Figures included under Bengal.
1907-08	53,252,540	25,495,800	16,882,800	66·2	31·7	
1908-09	53,461,119	23,475,000	14,586,900	62·1	27·2	
1909-10 . . .	53,420,236	27,131,700	17,887,900	65·9	33·4	
1910-11	53,172,976	27,511,000	17,752,100	64·5	33·3	
1911-12	53,172,976	27,556,300	17,365,000	63·0	32·6	
			UNITED PROVINCES.			
1902-03	66,608,042	35,397,590	6,960,542	19·7	10·4	
1903-04 . . .	66,541,410	35,711,023	6,038,543	17·0	9·0	
1904-05	65,322,151	35,905,391	7,084,314	19·7	10·8	
1905-06	66,301,596	34,994,635	7,078,563	20·2	10·6	
1906-07 . . .	68,704,040	36,666,179	7,726,690	21·1	11·2	
1907-08	68,869,634	33,104,452	6,966,654	21·0	10·1	
1908-09	68,826,104	35,888,646	5,892,018	16·4	8·5	
1909-10	68,841,165	36,594,600	6,120,518	16·7	8·8	
1910-11 . . .	68,272,114	36,250,036	6,034,108	16·6	8·8	
1911-12	68,275,839	35,590,711	5,274,742	17·6	7·7	
			PUAJAB.			
1902-03	57,324,137	22,705,117	605,895	2·6	1·0	
1903-04	57,132,701	24,911,540	687,626	2·7	1·2	
1904-05	57,150,019	23,217,955	573,727	2·4	1·0	
1905-06	57,188,064	24,112,119	493,062	2·0	·8	
1906-07	57,266,113	25,960,499	726,688	2·8	1·3	
1907-08	61,189,858	21,801,075	695,897	3·2	1·1	
1908-09	61,189,958	25,821,102	729,476	2·8	1·1	
1909-10 . . .	61,262,639	25,393,401	799,094	3·1	1·3	
1910-11	61,228,743	24,808,111	712,848	2·8	1·1	
1911-12	61,255,052	22,257,068	515,781	2·3	·8	

Statement showing the proportion of rice area to the cultivated area and the total area of the provinces during 1902-03 to 1911-12—continued.

Year.	Total area in acres.	Cultivated area in acres.	Area under rice in acres.	Percentage of rice area to cultivated area.	Percentage of rice area to total area.	REMARKS.
1	2	3	4	5	6	7
			NORTH-WEST FRONTIER PROVINCE.			
1902-03	8,461,071	2,024,784	25,536	1·2	·3	
1903-04	8,498,905	2,328,015	32,739	1·4	·3	
1904-05	8,464,135	2,018,378	28,368	1·4	·3	
1905-06	8,449,849	2,197,107	29,647	1·3	3	
1906-07	8,494,788	2,440,939	29,957	1·2	·3	
1907-08	8,493,124	2,195,614	29,240	1·3	·3	
1908-09	8,574,443	2,438,627	44,654	1·8	·5	
1909-10	8,574,346	2,396,991	40,774	1·7	·4	
1910-11	8,574,087	2,411,095	42,598	1·7	·5	
1911-12	8,574,452	2,284,540	47,181	2·1	·5	
			BOMBAY.			
1902-03	73,766,683	26,938,499	2,228,582	8·3	·3	
1903-04	73,844,981	27,902,9[illegible]3	2,447,711	8·9	·3	
1904-05	74,118,924	26,547,469	2,339,922	8·8	·3	
1905-06	71,230,199	25,843,833	2,526,163	9·8	·3	
1906-07	74,280,403	28,222,981	2,669,521	9·4	·3	
1907-08	78,681,697	28,059,216	2,694,450	9·6	·3	
1908-09	78,544,808	29,167,812	2,755,755	9·4	·3	
1909-10	78,694,222	20,168,429	2,960,6[illegible]2	10·1	·3	
1910-11	78,870,676	19,463,727	2,993,863	10·1	·3	
1911-12	78,886,729	25,847,065	2,770,690	1·07	·3	
			CENTRAL PROVINCES AND BERAR.			
1902-03	59,039,399	22,977,212	3,752,338	16·3	6·3	
1903-04	59,186,889	23,505,808	3,621,651	15·4	6·1	
1904-05	59,198,235	23,843,639	4,047,839	17·3	6·8	
1905-06	59,808,030	24,336,353	4,206,887	17·2	7·0	
1906-07	64,511,101	24,712,565	4,287,853	17·3	6·6	
1907-08	64,601,454	23,471,049	4,498,633	19·1	6·9	
1908-09	64,601,251	24,017,178	4,543,854	18·9	7·0	
1909-10	64,282,485	24,886,230	4,837,802	19·4	7·5	
1910-11	64,830,815	24,928,362	4,728,352	18·9	7·3	
1911-12	64,817,541	25,[illegible]26,300	4,821,921	19·2	7·4	
			MADRAS.			
1902-03	64,651,796	26,893,738	7,734,[illegible]5	28·7	11·9	
1903-04	64,710,056	26,973,974	8,276,529	30·6	12·8	
1904-05	66,441,505	25,525,978	7,221,603	28·2	10·8	
1905-06	66,907,801	26,411,306	7,561,611	28·6	11·3	
1906-07	67,471,633	27,556,342	8,048,383	29·1	11·9	
1907-08	87,155,867	33,909,679	10,613,906	31·3	12·1	
1908-09	89,571,650	33,755,804	10,904,685	30·5	11·5	
1909-10	89,015,611	32,217,294	10,359,209	32·1	11·6	
1910-11	88,718,900	33,754,796	10,781,336	31·9	1[illegible]	
1911-12	89,072,612	33,068,409	10,289,461	31·1	11·5	

Statement showing the proportion of the rice area to the cultivated area and the total area of the provinces during 1902-03 to 1911-12—continued.

Year.	Total area in acres.	Cultivated area in acres.	Area under rice in acres.	Percentage of rice area to cultivated area.	Pecentage of rice area to Total area.	REMARKS.
1	2	3	4	5	6	7
			COORG.			
1902-03	1,012,260	152,928	80,694	52·7	8·0	
1903-04	1,012,260	145,254	79,763	54·9	7·9	
1904-05	1,012 260	139,727	79,111	56·6	7·8	
1905-06	1,012,260	141,190	79,172	56·0	7·8	
1906-07	1,012,260	141,083	79,617	56·4	7·9	
1907-08	1,012,260	142,176	81,121	57·0	8·0	
1908-09	1,012,260	138,392	81,149	58·6	8·0	
1909-10	1,012,260	139,427	81,792	58·6	8·1	
1910-11	1,012,260	141,128	82,502	58·4	8·2	
1911-12	1,012,260	141,228	82,527	58·4	8·2	
			AJMER-MERWARA.			
1902-03	953,852	306,539	170	0·5	..	
1903-04	959,790	337,411	553	·1	...	
1904-05	960,565	327,570	275	0·8	...	
1905-06	960,563	187,492	171	0·9	...	
1906-07	974,226	346,861	249	0·7	...	
1907-08	1,654,685	356,627	618	·1	...	
1908-09	1,693,720	426,748	1,098	·2	...	
1909-10	1,770,921	418,162	1,266	·3	..	
1910-11	1,770,921	358,753	425	·1	...	
1911-12	1,770,921	220,175	139	0·2	.	
			PERGANA MANPUR (CENTRAL INDIA).			
1902-03	38,871	7,216	54	·7	...	
1903-04	38,871	7,585	69	·9	...	
1904-05	38,871	7,641	89	1·1	...	
1905-06	38,871	7,623	98	1·2	...	
1906-07	31,383	6,900	88	1·2	.	
1907-08	31,383	6,679	92	1·3	...	
1908-09	31,383	6,789	59	1·8	...	
1909-10	31,363	7,052	85	1·2	...	
1910-11	31,363	7,146	83	1·2	...	
1911-12	34,882	7,188	137	1·8	...	
			ASSAM.			
1902-03	18,802,973	5,073,806	3,998,001	78·8	21·2	
1903-04	18,492,149	4,947,237	3,960,020	80·0	21·4	
1904-05	18,416,603	4,963,920	3,963,886	79·8	21·5	
1905-06	18,487,614	4,822,129	3,803,253	78·8	20·5	
1906-07	22,920,104	4,389,243	3,430,813	78·1	14·9	
1907-08	30,024,743	5,113,336	4,062,849	79·4	13·5	
1908-09	31,305,574	5,416,369	4,345,736	80·2	13·8	
1909-10	31,305,574	5,582,276	4,482,507	80·2	14·3	
1910-11	31,305,574	5,560,514	4,406,156	79·2	14·0	
1911-12	31,305,574	5,711,698	4,616,197	80·5	14·7	

Statement showing the proportion of the rice area to the cultivated area and the total area of the provinces during 1902-03 to 1911-12—concluded.

Year.	Total area in acres.	Cultivated area in acres.	Area under rice in acres.	Percentage of rice area to cultivated area.	Percentage of rice area to total area.	REMARKS.
1	2	3	4	5	6	7
			BURMA.			
1902-03	101,627,616	11,400,602	8,333,020	73·0	8·1	
1903-04	104,019,392	16,966,507	8,678,502	54·3	8·3	
1904-05	104,012,329	12,555,048	9,265,097	73·7	8·9	
1905-06	104,005,441	12,399,208	9,283,801	74·8	8·9	
1906-07	114,653,248	12,575,471	9,307,078	74·0	8·1	
1907-08	112,987,608	12,842,308	9,400,952	73·2	8·3	
1908-09	113,004,338	13,652,676	9,798,352	71·7	8·6	
1909-10	114,000,262	13,857,845	10,080,203	72·7	8·8	
1910-11	108,793,095	13,309,525	10,010,557	75·2	9·2	
1911-12	108,799,142	13,339,916	9,894,261	74·1	9·0	
			INDIA.			
1902-03	554,052,949	205,239,350	71,633,546	34·9	12·9	
1903-04	554,234,736	208,273,095	69,596,654	33·4	12·5	
1904-05	555,974,330	207,720,964	73,525,388	35·4	13·2	
1905-06	556,599,298	207,683,741	73,400,528	35·4	13·2	
1906-07	583,746,733	214,026,319	73,541,118	34·4	12·6	
1907-08	619,456,133	210,883,511	75,980,682	36·3	12·3	
1908-09	623,155,293	218,039,911	72,804,536	33·4	11·7	
1909-10	624,358,714	222,911,547	78,730,642	35·3	12·6	
1910-11	618,581,099	223,064,601	78,524,391	35·2	12·7	
1911-12	618,605,938	215,981,683	76,636,887	35·5	12·4	

III.

Statement showing annual exports of rice *from provinces during 1902-03 to 1911-12.*

Year.	Quantity exported (in cwts.).	REMARKS.
	Bengal.	
1902-03	6,630,874	These figures represent rice not in the husk as well as rice flour exported.
1903-04	6,947,310	
1904-05	8,070,472	
1905-06	8,971,301	
1906-07	4,736,694	
1907-08	2,841,968	
1908-09	3,402,486	
1909-10	5,757,205	
1910-11	7,601,858	
1911-12	9,952,075	
	Bombay.	
1902-03	1,260,433	These figures represent rice not in the husk as well as rice flour exported
1903-04	1,116,703	
1904-05	1,111,635	
1905-06	888,953	
1906-07	1,891,379	
1907-08	1,472,495	
1908-09	1,255,778	
1909-10	1,514,847	
1910-11	1,078,602	
1911-12	787,816	
	Madras.	
1902-03	2,631,191	These figures represent rice not in the husk as well as rice flour exported.
1903-04	3,398,783	
1904-05	2,469,949	
1905-06	1,520,413	
1906-07	3,564,870	
1907-08	4,611,231	
1908-09	3,637,920	
1909-10	2,920,884	
1910-11	2,475,369	
1911-12	2,888,855	
	Burma.	
1902-03	36,819,371	These figures represent rice not in the husk as well as rice flour exported.
1903-04	33,855,435	
1904-05	37,632,484	
1905-06	31,894,894	
1906-07	28,303,951	
1907-08	29,146,711	
1908-09	21,786,553	
1909-10*	29,851,769	
1910-11*	36,615,463	
1911-12*	38,483,045	

Footnote.—Of the countries of export Straits Settlement, Ceylon, Germany, Java, Holland, Austria-Hungary, United Kingdom, Japan, Turkey (Asiatic) and Mauritius come foremost.

IV.

Statement showing the area, outturn and export of rice during 1902-03 to 1911-12.

Year.	Area under rice (in acres).	Outturn of cleaned rice (in cwts.).	Exports.		Remarks.
			Quantity (in cwts.).	Value (in Rupees).	
1902-03	71,683,546	469,484,800	(a) 451,962 (b) 47,033,137 (c) 7,424	18,89,52,506	(a) Rice in the husk. (b) " not in the husk. (c) Flour.
1903-04	69,596,654	439,280,700	(a) 560,565 (b) 44,441,186 (c) 3,327	19,08,49,230	
1904-05	73,525,888	448,461,100	(a) 613,075 (b) 48,879,297 (c) 2,529	19,62,04,232	
1905-06	73,400,528	433,138,300	(a) 828,745 (b) 42,208,473 (c) 4,594	18,63,81,496	
1906-07	73,541,118	427,743,800	(a) 655,132 (b) 38,053,973 (c) 6,165	18,52,95,096	
1907-08	75,980,682	379,211,300	(a) 553,168 (b) 37,700,155 (c) 3,472	20,33,91,086	
1908-09	72,800,536	390,979,900	(a) 577,699 (b) 29,673,771 (c) 3,900	15,89,02,516	
1909-10	78,750,642	557,186,000	(a) 809,910 (b) 38,394,371 (c) 3,722	18,24,46,049	
1910-11	78,524,391	557,938,000	(a) 693,894 (b) 47,302,837 (c) 5,859	23,23,52,055	
1911-12	76,696,887	521,993,000	(a) 1,105,268 (b) 51,372,150 (c) 2,768	29,05,18,440	

APPENDIX—E.

(1)

Subject IX.—Note on Agricultural Education.*

(J. MACKENNA M.A., I.C.S., AGRICULTURAL ADVISER TO THE GOVERNMENT OF INDIA.)

I.—Historical.

1. In the Fifth Quinquennial Review of the Progress of Education in India, 1902-07, dealing with Agricultural Education, the Director General of Education wrote:—

"537. A convenient summary of the long and complex history of agricultural education in India is given in paragraphs 793 to 814 of the 4th Quinquennial Review of the Progress of Education in India. From these paragraphs it will be seen that although much anxious consideration had been given to the subject and although there were in the year 1901 five institutions in India at which theoretical and practical instruction in agriculture was imparted, the results which up to that time had been achieved were in-commensurate with the time, labour and money which had been devoted to the subject; and it was considered that this result was due chiefly to the fact that the Agricultural Colleges and Schools were regarded primarily as an avenue to Government service, and the training offered at them had not been taken advantage of to any material extent by those who would turn their instruction to practical account in private farming and estate management. Having regard to these facts, the Government of India, in addressing Local Governments on the subject of the Proceedings of the Educational Conference convened at Simla in 1901, expressed a doubt whether there was any need in India for advanced theoretical instruction in agriculture and whether it would not suffice if practical knowledge were supplemented by a merely elementary acquaintance with such subjects as Botany and Chemistry. They also remarked that it seemed open to question whether the study of agriculture need be encouraged by the affiliation of the Agricultural Colleges to the Universities and the offer of degrees, and whether in some cases the attention which up to that time had been devoted to higher agricultural education might not profitably be diverted to elementary vernacular instruction in agriculture."

The previous history of Agricultural Education in India.

2. In the same year, 1901, an impetus had been given to the development of Agricultural Science in India by the appointment of an Inspector-General of Agriculture aided by a nucleus staff of scientific experts. In 1903, Mr. Henry Phipps made the donation which resulted in the crystallisation of the proposal to establish a fully equipped research Laboratory for this nucleus staff and the absorption in this project of the Bengal Government's original proposals for an Agricultural Research Station and experimental Farm at Pusa.

The policy of the Government of India as regards agricultural education at that time is expressed in a Resolution dated the 29th February 1904, as follows:—

"13. An Agricultural College is required at Pusa, not only in order to provide for the needs of Bengal, but also to serve as a model for and raise the standard of Agricultural Colleges in other provinces and to provide for a more complete and efficient agricultural education than is now possible in any of the existing institutions. The provision for agricultural education in India outside Bengal is at present as follows:—In Bombay and Madras there are Colleges at Poona and Saidapet, where the students pass through a three years' course. In the United Provinces there is a school at Cawnpore with a two years' course especially intended for the training of *kanungoes*, in which direction it has done and is doing very good work. In Nagpur there is also a school with a two years' course, and special arrangements are made there for a vernacular class for sons of landowners and the like. A good practical education is given there, and a promising student is yearly sent to Poona to finish his education, with promise of an appointment if his progress is satisfactory. The Saidapet College is under the Education Department, as is the one at Poona, though to a less extent. The Cawnpore and Nagpur schools are under the Agricultural Department. In all these institutions the education is given in English and at present this is unavoidable in all but the most elementary classes, owing to the want of advanced text books in the vernacular. In the Punjab and Burma there is at present no Agricultural School or College.

"14. At none of these institutions, however, are there arrangements for a complete agricultural education. Facilities are required for better practical training than it has been found possible to give at Poona or Saidapet, and these it is hoped to find at Pusa with its large farm and strong teaching staff. At the same time, provision is necessary for the extension and completion of the education acquired in provincial schools or colleges. A three years' course may possibly, especially if supplemented by practical work, afford a sufficiently good qualification for men whose life is not to be devoted to special agricultural work, but it is necessary also to provide for the training of the teachers of the future and of the specialists in the various branches of science connected with agriculture whom it is at present found necessary to import from Europe. Some organisation by which the men required for these purposes may be trained in India itself is essential, if the scheme of agricultural education is ever to be placed on a broader basis and made really efficient. The necessity for such an education is constantly becoming more apparent but progress must begin at the top and spread downwards. Before education in the vernacular is possible, it is necessary that natives of the country should be taught in English who will provide the text books for general use. It is admitted that for the production of a satisfactory text book even of an elementary character, in any subject, a high degree of training is requisite, and in scientific subjects now under consideration, such training is at present possible only in English. The education at the Pusa College will therefore be in English, with a view to the training of men who will make the spread of agricultural education in the vernacular possible in the future.

* This note represents the personal views of the writer and must not be taken as reflecting views adopted by official authority.

"15. Having regard to the present condition of agricultural education, it is essential in the first place that the College should be organised in such a manner as to provide for the education of the class of youths who at present attend the provincial schools or colleges It must begin where these schools begin, so as to provide for provinces in which no agricultural school exists. The second essential is that the College should provide for the carrying on of the training of pupils beyond the stage at which they leave their provincial schools or colleges, and that the course should be sufficiently extended to give a thorough education to those who wish to qualify for professorships, or for research work or for posts requiring special scientific attainments.

"16. For this purpose it is proposed that the complete course of instruction at Pusa should be one of five years. The general educational standard required for admission would be the School Final or the Entrance Examination. Those students who only require an elementary education with some practical work to qualify for the lower posts in the revenue service, would go through a two years' course, at the end of which time they would correspond with students who in the ordinary colleges have passed the First Arts Examination. The third year's course would bring the education up to the standard now given at Poona and Saidapet, in so far as length of time is concerned and it is hoped, to a high point as regards efficiency. This three years' course (which would extend to four years in the case of those who did not statisfy the tests imposed by the College) would complete the education of the majority of the students, and would correspond in a general way with the B.A. course in ordinary colleges. At this stage students proceeding with their education would be encouraged to specialise in any branch for which they seemed practically adapted such as Entomology, Chemical analysis, Botany and the like. Some students also, it is expected, would remain at the farm in order to still further accustom themselves to practical work, with a view to qualifying for the management of estates, either of Government or of private persons, without the intention of engaging in higher scientific work. It is perhaps open to question whether, if the school is successful the students who have come for a two years' course can advantageously be trained together with those who have come with the intention of undergoing the three years' or the complete course. The former class will consist of men qualifying for minor appointments, or aiming only at a practical training in the elements of agriculture, and their association with students who have higher aims may tend to retard the progress of the latter. But it is, the Government of India think, unnecessary at this stage to consider the question of having a separate two years' course especially adapted for elementary practical work, and apart from the general college course; and in this and other respects, matters of detail must be left for arrangement as the Institution developes.

"17. It will be open to provinces other than Bengal to send students to the school either for the whole course, or (with the consent of the Government of India) after completing or partly completing their training in the Provincial College. Instruction at provincial institutions would be accepted in the place of that given at Pusa up to any point to which it was found to be efficient; that is to say, the existing provincial institutions would, on the analogy of the Universities, be affiliated upto that point to which each was considered to give a thoroughly practical training. This power of affiliation will, it may be anticipated, enable the Government of India to exercise over the provincial schools and colleges for agriculture an influence which can hardly be otherwise than beneficial, and to gradually raise the standard of efficiency.

"18. The detailed curriculum which the College will embrace will be more fully elaborated by the Government of India in consultation with their agricultural and educational advisers when the scheme is further advanced. So far as it is at present formulated it will include:—

1. Agriculture (theory and practice).
2. Chemistry (inorganic, organic and agricultural).
3. Systematic Cryptogamic Botany.
4. Agricultural Entomology.
5. Geology, as applied to agriculture.
6. Elementary Physics and Mechanics in their application to agriculture.

The practical side of the training will include:—

1. Veterinary Science, so far as required by agriculturists.
2. Land Survey and Mensuration.
3. Farm management (practical), farm accounts and allied subjects.

"19. The Government of India turn now to the question whether there is likely to be a sufficient demand for the educational facilities which it is proposed to afford, and in what directions they may be expected to be of benefit to the public service and to private landowners in the country. There is, they consider, no reason to doubt that the classes of the first three years' course will be well filled with students apart altogether from the lower class who join only for a two years' course. Men with a still higher education will be required to fill posts in the Department of Agriculture itself, such as those of Assistant Directors, Research Experts, Superintendents of Farms, Professors, Teachers and Managers of Court of Wards and Encumbered Estates. If the results arrived at on the various experimental farms are to have wide effec within any reasonable period, it will be necessary to establish small demonstration farms in all parts of the country; and the Pusa Institute will provide the men who will take charge of them. The Government of India have also on several occasions emphasised the importance of having a leaven of men with an agricultural education in the higher posts of the revenue service, and if the College opens a w y to this service it may be anticipated that considerable numbers of pupils will attend it. The practical character of the instruction should provide a better class of men for active work, such as that of the Tahsildar and the like, than does the purely literary education which is at present available. But it is not only Government service that is looked to as offering inducements to young men to qualify themselves at the Pusa College. For some years past, if the insistence of the Native Press is to be accepted, there has been growing up among the land-owning classes a demand for men with agricultural training; and if the new college succeeds in turning out men of the right class, who combine with a sufficient theoretical training a thoroughly practical acquaintance with their subjects, a demand for their services may arise from the great land-owners of India which will do more to promote our objects than any attractions which Government service can offer. It is possible, however, that the two final years of school course may not at first attract very many students, and that those who come at this stage will, as a

rule, be persons who have a practically assured prospect of an appointment. Provincial Governments will probably be prepared to send the most promising men from their own Agricultural Colleges to take the higher course or to undergo a period of practical training at Pusa, giving them a scholarship, and holding out the expectation of an appointment on their return if they are well reported on. The Government of India would cordially approve of such arrangements. It is moreover not at all improbable that scholarships may also be provided by private persons. The fact, however, that a comparatively small number of pupils may take up the highest part of the course is an additional reason for making the Institution an Imperial one, which students from all provinces may attend."

* * * * * * * *

"26. Circumstances have combined to afford an unusually favourable opportunity of establishing an agricultural institution and farm in this country from which definite practical benefit may be expected to arise. The Government cannot at present find teachers of agricultural subjects, nor can they obtain trained practical men to manage experimental and demonstration farms, or to take service with the Court of Wards or with the Native States or with the large land-owners in their own territories. These requirements they trust that the Institute at Pusa will enable them to meet, while at the same time its trained staff and laboratories will provide facilities such as have not hitherto been available in this country for the application of higher science to those agricultural problems the importance of which to the welfare of India and its people it is hardly possible to exaggerate."

3. This statement of policy is important because although, with the great expansion of the Agricultural Department that took place in 1905, the functions of the Pusa Institute as regards education were reduced to providing the two years' post-graduate course only, the three years' degree course being relegated entirely to the Provinces, in all of which the establishment of colleges was then urged, no departure from the principles there laid down has since been made.

Reading this Resolution in the light of the attitude of Government in 1901, we may conclude that the Government of India were still somewhat sceptical as to the demand or necessity for higher agricultural education for farmers or managers of estates, but contemplated a very large development of "Agricultural Education in the Vernacular" with the help of text books, and of agricultural investigation and demonstration work; for all of which a large number of agricultural graduates would be required, while for the writing of text books, for research and as Professors of Agricultural Colleges, selected graduates would qualify by a two years' post-graduate study at Pusa.

Considerable numbers of students would, however, it was suggested, be ensured by making higher agricultural education an avenue to appointments in the higher posts of the revenue service.

4. This was in 1904. In Januay 1905, the Government of India sent a despatch to the Secretary of State for India in which the following passage occurs:—

"We desire to place all the chief Local Governments in funds to enable them to take effective steps for the development of agricultural experiment, research, demonstration and instruction. Circumstances with which you are already acquainted, prevented for many years any substantial progress in this direction. But we believe you will readily agree with us that, in a country so largely agricultural as India, a Government which owns the largest landed estate in the world should do far more than we are now doing for the improvement of local agriculture. The ultimate aim which we set before ourselves is, the establishment of an experimental farm in each large tract of country of which the agricultural conditions are approximately homogeneous, to be supplemented by numerous small demonstration farms, the creation of an Agricultural College teaching upto a three years' course, in each of the larger provinces, and the provision of an expert staff in connection with these colleges for purposes of research as well as of education."

5. In the Financial Statement for 1905-06 an announcement was made that a sum of 20 lakhs had been set aside for annual expenditure in India on the improvement of agriculture (including veterinary questions).

The Inspector-General of Agriculture and Inspector-General, Civil Veterinary Department, furnished the Government of India with detailed notes which were forwarded to Local Governments suggesting lines for the contemplated expansion.

The suggestions for the expansion of the Provincial Agricultural Departments made in Mr. Sly's note, consisted, for our present purposes, of three main items, the bearing of all of which on Agricultural Education will become apparent as we proceed.

These suggestions were:—

I.—The concentration under one Deputy Director of Agriculture in each province of all 'the special work that must be done as a foundation for all other research work, in relation to the growth of crops, the management of experimental, seed and demonstration farms, seed and plant distribution and the like;' and the extension of research by the appointment of specialists to deal with various crops, as well as additional Botanists, Entomologists and other specialists. The Deputy Director was to have an experimental farm in each important representative tract, under a good qualified Indian Manager, 3 or 4 such farms being suggested for each province.

II.—The provision of a number of Provincial Agricultural Colleges with a three years' course leading up to Pusa—with reference to which Mr. Sly says "I am much impressed with the danger that Pusa may be diverted from its primary object as a Research Station into a Teaching Institution only. The demand for men trained at the College, both by the provincial agricultural departments and private estates will be so great that it will be swamped by the large number of students."

III.—The establishment of a demonstration farm in each unit of Revenue Administration (Tahsil, Taluk or Sub-Division). Mr. Sly contemplated a demonstration farm of from 10 to 50 acres in charge of Subordinate Agricultural Assistants on Rs. 50 to Rs. 75, with a Travelling Inspector on Rs. 200—300 in charge of each group of, say, 10 farms, and suggested two groups each in Madras, the Central Provinces, and Bengal and one each in Bombay, the United Provinces, Punjab and Assam.

6. While these suggestions were under consideration by Local Governments, Mr. Sly made a tour through all the provinces, and discussed the matter generally with the men on the spot, embodying the result of these discussions in a Note, dated May 31st, 1905, in which he says, referring to the three principal items sketched above:—

"I wish first to draw attention to a criticism of the proposals put forward in my Note, dated the 16th January 1905, which was made by several of the most competent authorities. It was pointed out that the adoption of my proposal would result in a large Central Research Station and College, with a strong staff, to the partial neglect of the outlying agricultural tracts. For these latter, I suggested (1) an experimental farm for each important agricultural tract in charge of a good native subordinate and

(2) demonstration farms, where necessary also to be managed by a native staff, both to be inspected from time to time by the European experts from headquarters and more particularly by the expert agriculturist designated the Superintendent of Farms. I agree with the criticism that these proposals err on the side of over-centralisation. The diversity of agricultural conditions from tract to tract is so great that each demands separate and detailed investigation. At the present stage, almost all the native staff available is not sufficiently good to manage Government farms without constant inspection and supervision from European experts. Still less is the native staff competent to undertake the detailed investigation of the agriculture of each tract. Under such conditions a single expert agriculturist cannot undertake the investigation of the agriculture of a whole province and the supervision of all its Government farms. The expert must be familiar with every detail of the agriculture of his charge; he must be in close touch with the agriculturists: he must control the distribution of suitable seed to each part; *he must be able to recommend and distribute* improved implements; he must attend agricultural shows and the meetings of the agricultural associations; he must supervise the demonstration plots. Above all, he must be in close touch with cultivators in order to give them advice in response to their many enquiries. * * * * For such work it is essential that the expert should have a good knowledge of the local conditions and, in case of necessity, should himself examine the holding of the enquirer or send a qualified native subordinate to report upon the local details. Careful attention to, and encouragement of, such enquiries is one of the most hopeful ways of introducing improvements. It is one of the most important points of contact with the *cultivators. For all these reasons, each important* province is too large to be worked by one expert agriculturist. It must be divided into convenient circles with a Superintendent of Farms (as I prefer to call him in preference to the title of Deputy Director of Agriculture) in charge of each. This is so important that I look upon the duplication of Superintendents of Farms as more important than the appointment of some experts for research in more specialised sciences."

* * * * * * * *

"I also suggested tentatively for purposes of estimating (probable expenditure) the number of farms required by each province so as to provide one for each important distinct agricultural tract. My suggestion was based upon a very imperfect knowledge of several provinces, and most Governments show that the number suggested is too small to cover the general principle; they, therefore, prefer to spend the available money on more numerous smaller farms. This is another instance of over-centralisation in my proposals where I did not recognise sufficiently the importance of the diversity of local conditions. My main reason for suggesting a considerable area for each farm was to provide a supply of improved seed. I regret that this important branch of work will suffer in farms of small areas sufficient only for experimental and demonstration work. But Local Governments are certainly right in requiring more numerous farms and probably right in starting with smaller areas until a good native staff is trained up. The importance of seed distribution is bound to force itself more and more to the front with the progress of research work resulting in the production of new and improved varieties of crops so that larger areas for seed production will certainly come with development. At the present stage, I would accept the general opinion in favour of more numerous farms with smaller areas.

"All provinces accept the principle of the proposal for an expert staff, although the full complement of officers cannot be employed at once. Madras wants a second Superintendent of Farms in addition to the staff of five other experts; Bombay asks for the same, but is prepared to forego the second Agricultural Chemist (Professor of Chemistry at the Agricultural College). The United Provinces ask for four Superintendents of Farms for four circles or two in addition to the existing appointments of Deputy and Assistant Directors, making a total of eleven officers, but for the present would work without the second Chemist and second Botanist; the Central Provinces ask for three Superintendents of Farms in addition to the other expert staff. I think that all these proposed modifications are in the right direction and to other large provinces I would suggest the importance of dividing the province into a few agricultural circles and appointing a Superintendent of Farms to each, as a more pressing necessity than the appointments of second Chemist and second Botanist as professors of the agricultural colleges.

"Proposal (*c*) for the establishment of agricultural colleges is accepted by all provinces, and there is no alternative suggestion upon any matter of importance. I have noticed in the preceding paragraph some proposed modifications in the staff of European professors.

"Proposal (*d*) for the establishment of Demonstration Farms has brought out more diversity of opinion. Madras ultimately contemplates a farm in each district, partly experimental and partly demonstration with no separate demonstration farms. Bengal proposes fewer large experimental farms and ultimately a considerable number of demonstration farms. Assam wants one experimental farm and eight demonstration farms. Bombay desires no demonstration farm in addition to the proposed large number of permanent farms, partly experimental and partly demonstration. The United Provinces proposes an indefinite number."

7. Such then was the whole scheme of agricultural expansion of which the colleges were in every sense—and this is a very important point,—the central and not the fundamental unit.—

Firstly the provision of agricultural experts with a farm in each important tract '*for the special work that must be done as a foundation for all other research work*', and the extension of research by the appointment of numerous specialists.

Secondly coming to what Mr. Sly called the 'intermediate subject of agricultural education,'—agricultural colleges to train men for agriculture and for research.

Thirdly the demonstration of agricultural technique on a large scale by the men so trained.

And this scheme, by general consent, erred, if anywhere, on the side of over-centralisation.

The scheme had, however, been, in the main, approved by Provincial Governments and a despatch embodying definite proposals was sent by the Government of India to the Secretary of State for India on October 26th, 1905.

8. But here began a subtle change. The following extracts from the despatch referred to show very clearly the slight difference in the point of view:—

"Dealing with agriculture alone, we will first sketch the complete organisation to which, in our opinion, an approximation should be made in every large province.

* * * * *

"We propose to establish in each important province an agricultural college and research station, adequately equipped with laboratories and class rooms, to which will be attached a farm of suitable size.

* * * * * * * *

"The Institutions will fulfil a two-fold purpose. The problems connected with the agriculture of each province will be studied in the laboratory and in the field, while students will be given a thorough general education in all branches of agricultural science. The farm will afford a field for experiment and for the test of laboratory research, as well as a training ground for the students in the practical application of science to agriculture.

"Each Institution with the farm annexed will form the nucleus out of which the fully organised department for the province will be developed with greater or less rapidity as circumstances admit. The impetus and direction will come from the central source of activity thus provided: but it is also very necessary to provide for diversity of local conditions within the province."

Then follow recommendations for, what had been hitherto treated as the fundamental unit in the scheme, the division of provinces into representative tracts grouped under Deputy Directors—followed in turn by the third item, the provision for demonstration, etc.

This was the form in which the scheme went before the Secretary of State for India,—coupled with a request for sanction for an annual grant of 34½ lakhs instead of the 20 lakhs already allotted.

9. *Lord Morley's reply was as follows:—*

"Broadly speaking, it may be said that the Governments of the larger provinces favour the establishment in each province of an agricultural college with a minimum staff of three European experts, and consider that they will require after utilizing as far as possible the college staff for agricultural research and experiment, one or more additional European experts for the management and superintendence of farms and demonstration plots. The schemes provisionally sanctioned * * * proceed on these lines, and I am willing to accept the opinion * * * * that the general direction is right. It is evident, however, that the schemes of the Imperial and Provincial *Departments are capable of considerable expansion or contraction*, both as to the number of European experts and as to the size and number of farms and the scope of the experiments, according to the extent to which funds are available. As provisionally *sanctioned these schemes will require the development grant to be increased by 10 lakhs* of rupees a year, and the question arises whether this is necessary or expedient. The attempt to improve the agriculture of the country is still in its infancy and is an experiment of which the results are at present uncertain. Having regard to this I should have thought that a policy of cautious advance would be preferable, that departmental expansion should take place by degrees, that the staff of imported experts should for the present be closely restricted, and that the development of the Agricultural Department as they show signs of life, should be chiefly effected by means of an indigenous agency trained at the Central Institute."

The despatch then continued:—

"The proposal to increase, with effect from the next year, the annual grant of 20 lakhs of rupees to Provincial Governments for Agricultural and Veterinary development does not therefore commend itself to my mind."

* * * * * * * *

"I understand that the following experts are required, in addition to those already entertained, to enable Local Governments to establish Agricultural Colleges, with a staff of three Europeans:—

For the Punjab, Bengal and Burma, each, an all-round Agriculturist as Principal, an Agricultural Botanist and an Agricultural Chemist.

For the United Provinces and Madras, each, an all-round Agriculturist as Principal, and an Agricultural Chemist.

For the Central Provinces an all-round Agriculturist as Principal and an Agricultural Chemist.

"I agree to the creation of these appointments, and shall take steps to select suitable persons for them. *I assume that whatever reductions in the provincial schemes may be required to bring them within the financial limits which I have indicated as desirable for observance, the creation of provincial colleges having the above mentioned staffs will remain a primary feature.*"

10. The Government of India, while agreeing that colleges were most necessary protested against the curtailment of their proposals, and the grant was eventually increased to 24 lakhs; but the colleges had been made the primary objective, and in at least two provinces in Northern India the normal increase of expenditure on strictly agricultural work was, if anything, restricted rather than encouraged as a consequence.

The result is a matter of recent history and may be briefly summed up in the statement that the economic achievements and educational success of the various provincial departments of agriculture have been roughly proportional to the number of imported experts in each province whose time has not been entirely absorbed in tuition and inversely proportional to the area under the control of each such expert.

Where only one such expert has been employed on a large administrative area, the 'experiment' remains 'uncertain', there is no work for trained indigenous agency and the colleges have failed to attract students.

II.—Educational.

11. But this does not represent the whole extent of the deficiencies in the colleges. For even where the development of the Department's work has created a demand for the services of officials trained in the colleges, they have not provided the material required.

Detailed information as to the progress of the various colleges since 1907, is given in a Note on Agricultural Education, for the Quinquennial Review of the Progress of Education in India, prepared by the present Officiating Agricultural Adviser to the Government of India, who makes the following comment:—

"Experience is already showing that the courses originally prescribed in the Standard Curriculum for provincial agricultural colleges, as laid down by the Board of Agriculture and

amended in 1908 are, in most cases, not suited to the class of students that the colleges are intended for. Provincial reports are almost unanimous in tone. In *Bombay*, while the percentage of passes in the examination is high, the question of the utility of, and demand for, the course is obscured by its being made a road to a degree. College graduates on the subordinate staff have, with very few exceptions, continued to show no power to develop any original line. In Madras there is noted in graduates "a lack of intelligent inquisitiveness and power of independent thought". Similarly in the Punjab "There is too much cram and too little power of practical application."

There are some who see in this only a proof of the limitation of the capacity of Indians. But others not only refuse to take this pessimistic view, but have always held and expressed the opinion that an attempt to teach upto the standard syllabus prescribed by the Board of Agriculture in 1906 was bound to end in failure.

12. An examination of the documents relating to the constitution and framing of the curriculum of the colleges reveals the following facts:—

The Government of India in paragraph 18 of the Resolution of February 29th, 1904, quoted above, stated, with reference to the skeleton curriculum for the Pusa College "the detailed curriculum which the college will embrace will be more fully elaborated by the Government of India in *consultation with their Agricultural and Educational Advisers* when the scheme is further advanced."

In the programme of the 1st Meeting of the Board of Agriculture held in January 1905 the subject of agricultural education is introduced as follows:—

> "Mr. Mollison proposes during his furlough to *visit agricultural colleges in England, consult* professors, and draft a curriculum of studies for the Pusa Agricultural College. This subject is therefore not ripe for discussion."

Mr. (now Sir Alex) Pedler, Director, Public Instruction, Bengal, was present at the meeting but the discussion had reference to the question of rural education and the training of teachers only. The Bombay Government had recently proposed to raise the character of the training given by the Poona College, and the Government of India had welcomed the proposal as likely to provide students for advanced training at Pusa and was already contemplating the establishment of a college in each province. The idea that the three years' course was to be delegated to provincial colleges was therefore already in the air and explains the attitude of the Board of Agriculture, which considered 'that as Pusa is principally a research Institute the present scheme does not admit of teaching a large number' of normal school teachers.

13. Thus no action was taken at Pusa with a view to the elaboration of a curriculum until 1906, when there were no representatives of the Education Department at the Board of Agriculture's Meeting, but the programme included "a consideration of the curriculum of studies best suited for provincial agricultural colleges and schools. A subsidiary matter is the designation or title which should be allotted to passed students."

The following is the official account of the First Day's Proceedings of the Board with respect to this item of the programme:—

> "The President then initiated a discussion on some general principles connected with agricultural education, in order to allow of early reference being made to sub-committees of the Board for the purpose of drawing up a standard curriculum for agricultural colleges. He reminded the Board that their functions are advisory only, and that the very different local conditions of each province make it impossible to lay down a fixed course of study applicable to all India. He pointed out the danger of attempting to include too much in the course of studies, and suggested that the separate subjects of study should be limited as far as possible, because of the danger of attempting to teach more than the time of the course and the ability of the students would permit.
>
> "The Board decided to frame a standard curriculum, which might serve as a guide to assist provincial departments in settling their college schemes; that the standard curriculum should be drawn up for a full three years' course of education, with the object of turning out students with a general knowledge of agriculture which would fit them for upper subordinate posts in agricultural departments, and for employment as managers of court of wards and private estates. It was agreed that the Board should propose a certain minimum course, which should be held as essential in all colleges, but which should allow of a margin for expansion or modification to meet special local conditions.
>
> "In regard to the standard of educational qualifications which should admit of entry to agricultural colleges, the Board is of opinion that the minimum qualification should be that required for the Entrance, Matriculation or some examination of equal standing, except in the case of private students who may not have in view employment in Government service, and who may be admitted on the Principal of the College satisfying himself that the general education of the student is sufficient to enable him to benefit fully by the instruction provided, even though he may not have passed any public examination. A good knowledge of English is held to be essential for all students.
>
> "The Board is of opinion that the course should be subdivided for the purposes of drawing up a curriculum into the following main sections:—
>
> (1) Agriculture, including Geology and the Study of soils;
>
> (2) Chemistry and Physics;
>
> (3) Biology, including animal Physiology and Entomology;
>
> (4) Other and minor subjects, including Surveying, Mensuration, elementary Engineering, Veterinary Science, Meteorology and the like.
>
> "The working hours may conveniently be assumed to be thirty-three a week, divided into five days of six working hours and a half day of three hours on Saturday. Taking the working year at about eight months, this provides for a total of eleven hundred hours a year, and it is proposed to allot this for the purposes for framing a curriculum as follows:—Agriculture 35 per cent. of the total working hours, Chemistry and Physics 25 per cent., Biology 25 per cent. and minor subjects 15 per cent.
>
> "The Board further recognises, as a general principle in agricultural education of the sort contemplated, that the purely scientific teaching which is required should, as far as possible, be provided at an early period in the course, so as to permit the latter stages being held free for the application of these sciences to practical agriculture.
>
> "The following Sub-Committees were nominated:—
>
> (1) *Agriculture.*—Messrs. Moreland, Benson, Fletcher, Clouston and Hayman.
>
> (2) *Chemistry and Physics.*—Mr. Lawrence, Drs. Leather, Lehman and Mann and Mr. Meggitt.

(3) *Biology.*—Messrs. Oldham, Barber and Gammie, Captain Gage and Messrs. Howard and Lefroy.

(4) *Other Subjects.*—Messrs. Renouf and Knight, Colonel Morgan and Mr. Smith.

"The Sub-Sommittees were requested to prepare their respective syallabuses by Thursday, January, the 18th. Each Sub-Committee will then nominate two of its members to form a general committee who will co-ordinate the results and submit them to the Board in a consoldiated form on Friday, January, the 19th."

14. On January 19th the Board considered the report of the General Committee and accepted the "Standard Curriculum" which as slightly modified by the Board in 1908 (see introductory remarks) was in turn, accepted by the Government of India, published in Bulletin form and adopted by all Directors of Agriculture.

Mr. Sly the President had suggested that it was impossible to lay down a fixed course of study applicable to all India, but serious departure from this Standard Curriculum were to all intents and purposes prevented by the Board in their Resolution on the 'Subsidiary Matter' of the designation of passed students, *viz.* :—

"The Board considers that some form of degree or diploma should be conferred by Provincial Agricultural Colleges. In view of the danger that diplomas conferred by individual Colleges should have a different value, and to secure uniformity, it suggests, that a combined diploma should be given and that the Government of India be moved to recognise it as equal to the B. A. degree. As regards the exact title conferred, the Board consider that some such title as Licentiate of Agriculture (L. Ag.) may suitably be given."

Which Resolution was approved by the Government of India (Circular No. 30-28-41 of 8th October, 1907).

15. Now there is a significant fact about the way in which this Curriculum of Agricultural Education was elaborated.

The 'subjects' were chosen and the time for each allotted (presumably by a majority vote) by a Board of 35, *of whom none were professional teachers and only 11 could be called agriculturists.*

Secondly, the Syllabus in each subject was adopted by a group of specialists in that subject assisted by a member of the Indian Civil Service.

The natural inference which is supported by a study of the 'consolidated form' of the standard curriculum, is that it consists of a number of independent courses each complete in itself, and all compressed into the allotted time; without any reference to the capacity of students in general or of Indian students in particular, or to the limits to which any of the subjects could be pursued with advantage in a general education or by practical agriculturists. 'Agriculture' had been amply provided for in a watertight compartment to which had been allotted a preponderating number of hours per week.

16. The realisation is now slowly being enforced, that there is not, in Northern India at any rate, any educational basis on which such a curriculum can be grafted, and it seems probable that even the partial success achieved in some of the Colleges in Southern India is due entirely to the sufficiency and efficiency of the staff of the departments concerned, and has been obtained in spite of the standard curriculum.

As regards filling the Colleges, this can of course be secured, regardless of all possible defects from the educational point of view, by taking a purely academic standpoint and affiliating the College to the University, thus giving an ordinary academic degree of a standard appropriate to the educational position of the Province: or, again, by throwing open a sufficient number of Government appointments to passed students, and lowering the examination standard until a sufficient number of students pass. But no one would defend the latter course, while the former has been condemned by the Government of India.

17. And this brings us to the question of the extent to which agricultural educational policy has been guided by the Government of India and how far it may now be possible, without any reversal of such policy, to adapt the Colleges to ends likely to be useful to agriculture.

An early reference to a definite policy is contained in a letter to the Government of Bombay dated November 6th, 1901, from Mr. (now Sir) John Hewett, then Secretary to the Government of India in the Home Department.

"In regard to Agricultural Education (referred to in Resolution Nos. 55, 56 and 57), it appears that the training which has been offered by Government, whether as a three years' course at Poona and Saidapet, or for two years at Sibpur, Cawnpore and Nagpur, has not been taken advantage of to any material extent by those who would turn their instruction to profit in private farming or estate management, and that Agricultural colleges and schools have been regarded mainly as an avenue leading to Government service. It is no doubt desirable that the officials employed in such branches of administration as those connected with the maintenance of village records or the settlement of land revenue, should have some practical acquaintance with the conditions with which they have to deal, and provision may be usefully made for training them in agriculture and land surveying. But it appears open to question whether the instruction need be so advanced or so theoretical as it is in some cases, and whether practical knowledge need be supplemented by more than an elementary acquaintance with such subjects as Botany or Chemistry. In this case a two years' course would probably suffice and would perhaps be more likely than a three year's course to attract those who wish to learn agriculture for its own sake. It is, further, open to doubt whether the study of agriculture should be encouraged by the affiliation of Agricultural Colleges to a University and the offer of a Degree. In some circumstances development might indeed more profitably follow the contrary direction, vernacular being substituted for English as the medium of instruction and the course being thus thrown open to those who have not taken up English in their school studies. A vernacular course would offer an incidental advantage in providing a means of giving village school masters such training as would enable them to explain to their scholars the meaning of lessons in agriculture and elementary science. But the principal argument in its favour is that it may popularise the study of agriculture amongst those who live by its pursuit and are now debarred from it by their ignorance of English. It should of course be the policy of the Government to give all possible encouragement to students of this class, and the Governor-General in Council would be glad if consideration were given to the practicability of a further development in the establishment in those provinces where it may be found desirable, of a special school, of somewhat superior class for the sons of landholders, in which instruction, while perhaps following to some extent the ordinary school course would include practical training in subjects, such as agriculture, land surveying and farm book-keeping, which would be of use to the students in after life."

Further reference to the same policy occurs in paragraphs 13 and 14 of the Resolution of February 29th, 1904 already quoted (pages 1 and 2 above).

18. From a study of these pronouncements it appears that up to the end of that year the policy of the Government of India was to encourage elementary vernacular instruction designed to 'popularise the study of *Agriculture* amongst those who live by its pursuit and are now debarred from it by their ignorance of English.'

It is clear that what was intended in this sentence, was not the study of agriculture at all, but the study of elementary science and the application of the scientific method to rural phenomena.

However, to use the words of a Circular (No. 30-28-41) addressed to Local Governments on 18th December 1907, "the situation has been completely changed by the immense expansion of the Agricultural Department, which has taken place in recent years and the demand that has consequently arisen for highly qualified native subordinates."

The magnitude of this demand appears to have been exaggerated and the nature of the required qualifications misunderstood, but paragraphs 3 to 11 of the same circular set out the new view adopted by the Government of India in consequence of this 'complete change' and to show that while the problem of rural vernacular education was apparently no longer considered in connection with development of the Agricultural Department, the former policy as regards the affiliation of Agricultural Colleges to Universities was maintained, in consequence of a doubt as to the *qualifications of University Senates for advising regarding the management of Agricultural Colleges.*

This policy has been approved in the Resolution No. 1-234-10, dated 4th January 1910, and has been the basis of recent Government action as explained in a letter (No. 954 of 11th October, 1912 to the United Provinces Government) in which a proposal to affiliate the Cawnpore Agricultural College to the Allahabad University was negatived by the Government of India.

The *policy would appear to be based on two considerations: firstly, the desire to free the Agricultural* Department from all connection with the Universities, and to avoid overlapping with the Education Department as evidenced in the documents cited above; and, secondly, a doubt as to the expediency of the affiliation of geographically isolated teaching institutions, expressed in paragraph 45 of the recent Resolution (No. 301 C.D. of 21st February 1913) on Educational Policy.

19. The maintenance of 'Agricultural Colleges' can be made consistent with this policy either by converting them into purely technical institutions under the Agricultural Department or by turning them into rural colleges affiliated, or independent, under the Education Department; but in the former case the scientific side of the present curriculum would have to be drastically altered, and in the latter the agricultural side wholly omitted, and a rural bias given by the use of natural rural phenomena for illustrations in the teaching of science and of the application of the scientific method.

There has now long been a consensus of opinion that agriculture, as such, is not a fit subject for teaching in schools (it is not in fact a 'subject' at all) and that rural education must be as general as agricultural education should be technical.

The existing idea of an Agricultural College, however, appears to be a compromise between these two incompatible ideals, and it is probable, as suggested above, that the existing institutions will have *sooner or later to choose between becoming rural University Colleges, teaching what may, for* want of a better term, be called 'Rural Philosophy,'—for the sons of wealthy landholders and scholars aspiring to educational and research appointments—or farm institutes giving courses in highly specialised agricultural technique for professional agriculturists. The upper ranks of the Agricultural Department would be filled by men whose education had culminated in the fomer type of institution; the lower ranks, partly at any rate, by men trained in the latter.

III.—Conclusions and terms of reference.

20. In the preceding paragraphs we have attempted to give an historical retrospect of the developement of Agricultural Educational policy in India and a description of the present practice. It now remains to detail the points of reference for the consideration of the Committee. But before the whole question is discussed by a large and representative Committee it seems to be desirable that we should have from the Deputy Directors of Agriculture an expression of opinion on the following points:—

(*a*) What difficulties are met with in dealing with cultivators which can be ascribed to defective education and in what respects is the education of cultivators defective?

(*b*) What assistance can the Agricultural Colleges give in educating the cultivator, generally or technically?

(*c*) What educational and practical qualifications are required in recruits for the staff of the Agricultural Department? Can they be classified into grades of different educational qualifications?

With the opinions of the Deputy Directors on these points before them, the Education Committee will consider the following points of reference:—

(*i*) for what classes of persons should education be provided at the Agricultural Colleges and what general forms should such education take;

(*ii*) in what respects is the present College Education deficient and how should this be remedied;

(*iii*) what additional agricultural education, if any, should be provided outside the Colleges.

APPENDIX—E.

(2)

Subject IX.—Agricultural Education.

(J. H. Barnes, B.Sc., F.I.C., F.C.S., A.R.I.P.H., Principal, Agricultural College, Punjab.)

A Note on the Punjab Agricultural College for the information of the 8th meeting of the Board of Agriculture at Coimbatore in December 1913.

During the past two years it has become more and more evident that our system of agricultural education is not a success so far as the Punjab Agricultural College is concerned. The expense incurred by Government in giving the education at Lyallpur is out of proportion to the number and quality of the finished product, and the failure to recruit this year shows that the cost in effort and money to the Indian student is too high as compared with the salary he can command as a licentiate of agriculture afterwards.

At the time of the inception of the College it was hoped that the greater portion of the past students would find a livelihood in practical farming, and in order to further this object every effort has been made to secure the sons of agriculturists as students. Our hopes have not been fulfilled, for out of sixteen holders of our diploma, only one, a Jat Sikh, is engaged in private farming.

It is now fairly evident that the candidates for entrance to the diploma classes in this College have Government service as their main object, and the failure to secure students this year must in large measure be attributed to the fact that more remunerative employment can be obtained through other educational avenues. It appears to me necessary therefore to make a careful enquiry into all our Indian agricultural colleges and their system of working, and, with due regard to their requirements and the state of progress of each province, to see in what respect they are successful.

I do not wish success to be judged only by the number of students passing the test of the diploma examination or by the number of candidates for entrance to the College, because these will be ruled by the cost of the education, the standard of examination and the competition which exists among the educated classes for employment. The success of an agricultural college must be estimated rather by its capacity to supply a class of practical scientific farmers, capable of efficiently filling the ranks of an agricultural department and of meeting the demands of the progressive section of the agriculturists of the province. Of these two, I consider the second the more important, since this must constitute the main justification for the upkeep of a large and expensive educational institute. If there is no demand for the products of the college outside Government service, it means that the college is ahead of its time and a more lowly system of education will suffice to supply the present needs of the people. In this case we are driven to ask the question whether the present expenditure is justified for the mere purpose of increasing the competition for Government employment.

As will be shown later, the College expenses in 1912-13 were Rs. 98,277, the income Rs. 11,739, and the number of successful diplomates eight, or the cost incurred by Government in producing each graduate is nearly Rs. 11,000. I have debited the entire expenses of the college, with the exception of the pay of laboratory and research assistants, to education, because during the past five years the college staff have been occupied for the most part with educational work. Even allowing 25 per cent. of the expenses to be debited to research, *a very liberal figure*, it would still leave us with a bill of some Rs. 8,000 as the cost of educating one licentiate in agriculture. This is purely the recurring expenditure of one year, and no account has been taken of the heavy initial cost in buildings and equipment or of the recurring expenditure in previous years. On the same basis of calculations the cost per licentiate in 1912 was about the same (Rs. 92,517 less 25 per cent. for research and 8 successful licentiates).

If these men do not become active disseminators of agricultural knowledge, but are only capable of employment in the ranks of a service such as the Agricultural Department, we are forced to ask ourselves whether an equally effective staff could not be put together at less cost from among the present educational institutes of the country, after giving the men special training on the farms and in the laboratories of the Agricultural Department.

The present session of the Agricultural College at Lyallpur has opened without any student appearing in the 1st year class. I received in all 15 applications for admittance to the College as fee-paying students, and 25 applications for the entrance scholarship examination, but only 7 of the former and 11 of the latter attended the College for interview and for examination, respectively. Admission was given to 12,—seven scholarships being granted—but none of the students have yet appeared, and many of them have replied to my enquiries that they now propose joining other colleges. The Medical College appears to have the preference as several of my last year's students have left the Agricultural College to take up a course in medicine. This may be due to the proposed increased expenditure by Government on Sanitary Science and the resulting prospect of increased employment. As there can be no question that a medical qualification requires a longer period of study and is much more difficult to obtain than the Diploma of L. Ag. at Lyallpur, we must attribute this preference to the higher salaries commanded by a graduate in medicine.

I am led to the conclusion therefore that both our standard of education is too high for the type of student we can obtain, and the salary commanded by our licentiates is too low, and that in order to render the College popular and induce competition for entrance we must either lower the standard of education, or increase the pay of our departmental assistants who will be drawn from among the graduates of the College, if we are to command a full roll of students.

I do not consider the standard of the present licentiate in agriculture sufficiently high to permit of any reduction either in the time devoted to his training or in the standard of subjects taught to him. The lowering of the standard of education would therefore be fraught with danger to the future progress and development of the Agricultural Department which has to be largely staffed by these men.

There remains therefore only the prospective inducement of higher pay to secure a full roll of students. In my opinion neither of these two remedies appear sound or likely to yield results of lasting value so far as the popularity and utility of the College is concerned. It will be necessary to improve the prospects of Agricultural Assistants, but this is a matter which can be considered separately. The difficulty lies deeper and is to be associated with the existing elementary education in the Province, which is not sufficiently extensive or of a sufficiently high standard to induce healthy competition in higher education. It appears to me that, having regard to the needs of this Province, the higher teaching institutes are out of proportion to the existing elementary education, and

that the latter requires extension and amplification before such colleges as the Agricultural College at Lyallpur can obtain regular and satisfactory recruits.

It seems that we have reached a stage in Agricultural Education in the Punjab where it is necessary to review our policy and see where it is leading us to, and to make such changes as appear desirable. These changes should I consider come under the advice of the Board of Agriculture.

I have summarised the general situation into the following nine heads which might form a basis for discussion by the Board, and upon which resolutions could be passed. I shall make what reference I can to the Punjab Agricultural College under each of these headings:—

(*a*) To what extent is it advisable under existing conditions in India to extend higher education in scientific agriculture, and elementary agricultural education and in the form of Vernacular courses and farmer classes, in the existing agricultural colleges?

(*b*) To what extent can the licentiates of these agricultural colleges be given employment? What is their market value in different parts of India and whether in applied Agricultural Science either in field or laboratory such a licentiate is more intelligent and original than an ordinary University graduate with post-graduate training?

(*c*) The relations which do or should exist between agricultural education and higher education (University) on the one hand and primary education on the other.

(*d*) The revision of the curriculum for Indian Agricultural Colleges in view of the past five or six years' experience.

(*e*) A consideration of the necessity or otherwise of standardising the diploma of licentiate in agriculture.

(*f*) Recommendation for a curriculum for vernacular courses. Should this curriculum be standardised or should it differ in different provinces?

(*g*) Recommendations with regard to the staff required to carry out the above with special reference to the utility of Indian assistants and how far the existing Indian assistants can be independently used for—

(*i*) Teaching.

(*ii*) Research.

(*h*) A consideration of the advisability of placing the subject of agricultural education permanently on the agenda of the Board of Agriculture.

(*i*) The relative importance of agricultural education compared with investigation and research.

(*a*) *To what extent is it advisable under existing conditions in India to extend higher education (1) in Scientific Agriculture and (2) in Vernacular Courses and Farmers Classes?*

(1) *Higher education in scientific agriculture.*—As will be seen later under heading (*c*) our experience during the past five years has proved that the University Entrance Examination is not of sufficiently high standard to enable its holders to satisfactorily assimilate the course at Lyallpur, and that students possessing a better elementary education than this have done better on the whole in all subjects, irrespective of whether they were the sons of zamindars or not. The present difficulty of recruiting students for the Agricultural College precludes the possibility of raising the entrance standard under existing conditions. This combined with the fact that the greater number of these students are candidates for Government employment and only enter the college so long as they have a good opportunity of securing well paid posts, indicates the necessity of exercising reserve in the extension of expenditure on higher education in scientific agriculture here, and of scrutinising carefully the present system of training staff for the Provincial Agricultural Service to see if a cheaper and equally efficient method cannot be devised.*

The experience gained in agricultural education in other countries seems to indicate that, generally speaking, the students taking the higher University courses in scientific agriculture all do so with the object of practising either scientific farming or one of the sciences bearing on agriculture and very seldom take up any other employment. Boys attending purely practical farmers classes of short duration also do so with the object of applying the technical knowledge which they learn there, and as these classes do not qualify them for any other means of livelihood save farming, they almost invariably return to it. Between these two limits agricultural education results in a large proportion of the trained men taking to other sedentary occupations.

If we can generalise on the experience gained in other countries—and I think we are justified in doing so—this means that agricultural education in India should be of two types,—the very best, on the one hand, in which the training shall be of such a highly special nature that the finished product shall have a higher market value as a specialist than he can have as a merely educated man, and will ensure him seeking employment in this direction.

On the other hand, the education should be of so simple and yet so special a type that only the tillers of the soil will be attracted and benefit by the classes. Between these limits education should not be given by the Agricultural Department, as it will only bring this Department into competition with the Department of Public Instruction, and by adding to the number of existing colleges tend to lower the education standard. At the present time the only employment outlet for the first class in the Punjab seems to be in the Agricultural Department itself, and there the appointments and pay are too scanty to induce healthy competition. The result is that we cannot command as intelligent a class of students as the University colleges, nor can we secure them in sufficient numbers. This means that we must offer sufficiently good salaries and prospects in the Agricultural Department to induce the more intelligent boys to compete. The extent to which this higher education should be carried at present in this province should be limited by the vacancies in this Department, for experience has shown that the present external demands are not such as to induce students to enter the profession. There is no immediate need for over production, and indeed this will only lead to a falling-off in the quality of the candidates. What we want during the opening years is quality rather than quantity so as to gain the confidence of the public. A few years' demonstration by an adequately and efficiently equipped agricultural department will fix the market value of such men and will prepare the way for this type of education on a larger scale. Economic competition must follow later.

(2) *Farmer classes.*—We have held at Lyallpur a number of classes varying from the simplest type of out-door instruction in the use of improved implements, to an organised vernacular course extending over six months, the syllabus of which will be found at the end of this note. In the case of the farmers classes these were attended by local zamindars and were consequently of direct practical utility. This also applies to the case of military farm overseers sent to Lyallpur to learn the use of English ploughs and reaping machines. Out of 13 students taking the vernacular course,

* Briefly summarised in the Ceylon Journal of Agriculture for June 1913.

2 are now engaged in farming. This seems discouraging at first sight, but it must be remembered that the men and the training they receive are unknown and for the present their value is not understood. Later on with better district organization we shall be able to provide an outlet for men of this type in private service as well as in Government employment on seed farms and such like. I am of the opinion that these vernacular classes should be extended and should constitute our main educational effort at the Punjab Agricultural College for some years to come. I have suggested a means of effectively controlling the employment of boys leaving the class by giving district co-operative credit societies and agricultural banks the privilege of selecting candidates for entrance *and requiring on our part their guarantee that their nominees shall be actually engaged in farming* in their own villages for a period of at least a year after their return from the Agricultural College. If this can be done, it will aid in co-operation between such societies and the Agricultural Department in bringing the results of this department's work to the notice of the cultivating classes. It would I consider be a sound investment for Government to subsidize such students and cover the entire cost of their education and keep while at Lyallpur.

(b) To what extent can the licentiates of Agricultural Colleges be given employment? What is their market value in different parts of India and what is the relative value of these licentiates compared with University graduates with post-graduate training in Agricultural Science?

1. The main opening at present in this Province is in the Agricultural Service where the probationer starts on a salary of Rs. 40 rising by increments of Rs. 6 to Rs. 100* in the lower grade. *These prospects are not sufficiently good to attract suitable men.* There is a small demand for the Punjab licentiates of agriculture outside the Provincial Agricultural Service, but this demand is not sufficiently great or well known, nor is the pay offered sufficiently high to have any marked effect in attracting students to the College. Here and there are one or two posts carrying a good initial salary, but these offer no future prospects. It will be necessary to raise the initial pay and improve the prospects of Agricultural Assistants in this Province if we are to obtain the services of suitable men. This matter is now receiving the attention of the Punjab Department of Agriculture, and proposals are about to be submitted to Government.

I also recommend that an employment bureau be opened by the head of the department, and that suitable employment be offered to all men trained by us. The existence of such a bureau will become known in time and employers requiring assistants will then know where to apply for men. This in itself will, I think, assist in advertising and popularising the department, and will moreover regulate the *suitable* employment of our old students.

The market value of the Punjab licentiates in agriculture.—Though these men can only be said at present to be worth Rs. 40 per mensem as an initial pay since the chief employment open to them offers this, I consider they are worth more. Comparing the cost of their training in time and money and the type of work they will be called upon to do, with such other Government employment as exists in the Civil, Educational, Medical and Public Works services, I estimate that these licentiates should commence on Rs. 70 per mensem, and should be able to rise rapidly for the first 12 years, and that during this time the selection of men should be carefully carried out.

A comparison of the value of licentiates of Agriculture with University trained men, who have afterwards received post-graduate training in agriculture or one of the sciences.—Our experience at Lyallpur is in favour of the more highly educated men for such posts as laboratory assistants in science and for the posts of assistant directors, who are the first assistants of the Deputy Director in his district work and who at present have a good deal of clerical work. The men trained in an Agricultural College are, however, superior for the details of farm management and for the supervision of work necessitating good technical knowledge. Educationally, however, they are weak and do not satisfy us in their powers of applying what they have learnt, and this indicates the necessity of raising the entrance standard for the College and lengthening the course of study there, if we are to turn out men capable of successfully filling the posts of first grade agricultural assistants and of assistant directors. I consider that these posts should be recruited only from among the ranks of agricultural assistants, who should be sufficiently well educated to bear the increased work and responsibilities of promotion. This will, moreover, give us the great advantage of experienced technical men in the higher grades of the provincial service. The present difficulty of obtaining recruits renders the lengthening of the course and the raising of the entrance standard impossible unless we can offer higher inducements. It is of prime importance that a sufficient number of suitable men be recruited annually for the Agricultural Department, and in order to ensure this I recommend that five Government scholarships be given annually on the results of a competitive examination; that the subjects of this examination be elementary Chemistry, both Inorganic and Organic, elementary Botany, including elementary Morphology and Anatomy, elementary Physics and elementary Applied Mathematics including Statics, Hydrostatics and Dynamics, elementary Pure Mathematics including the binomial theorem, and the theories of indices and logarithms, elementary Agriculture; that candidates for this Entrance Scholarship Examination must be the sons of zamindars, either owners or cultivators of the soil. The scholarships shall carry with them free tuition for a period of three years and free entrance to the diploma examination, together with a maintenance bursary of Rs. 15 per mensem to cover hostel and other expenses, and employment in the Agricultural Department as an Agricultural Assistant on a pay of Rs. 70 per mensem at the end of the period: Provided that—

(*i*) the student satisfies the Principal of the College by his regular attendance at classes and proper progress in his studies;

(*ii*) that he enters the agricultural service for a period of not less than eight years.

If he fails in (*i*), he will be dismissed and his scholarship cancelled, and if he leaves the agricultural service before the expiry of eight years of service or is dismissed from the service, he shall refund the cost of his education, reckoning it at the rate charged in fees to other students. These scholarships will guarantee the regular expansion of the department by an outturn of five diplomates per annum. They will automatically raise the standard of education in the College and will allow us to dispense with a large amount of elementary teaching which now occupies the time of the staff, thus freeing the latter to give more attention to the detail training of the student on the technical side of each subject. This will also dispense with the necessity of lengthening the course.

(c) The relations which do or should exist between Agricultural Education and Higher Education on the one hand and Primary Education on the other.

The reports of the board of examiners for the diploma examination of the Punjab Agricultural College have for the past two years emphasised the necessity of a better elementary education for students entering on a course of scientific agriculture, and attribute the failure of the present system to turn out men capable of applying what they have learnt largely to this want of a good sound

* See page 163 for details.

primary education before entering the College. This defect is the cause of backwardness and cramming on the part of the student.

I anticipate that the attraction offered in better pay and free tuition would enable us to secure students who have spent two or three years at the University, and if this can be done we shall be able to recruit and train a better type of man for the agricultural service. This is essential if we are to open out the higher branches of the service to agricultural assistants. It is doubtful, however, if students will spend several years at the University and then abandon the chance of a degree for employment on the above lines. The education they will receive at the Agricultural College should be recognised as additional and continuous to that which they will possess on entering such a College. It should be possible for the best of these students to obtain their University degree as well as their diploma of licentiate in agriculture. I have indicated above the necessity of the highest type of education for training specialists in agriculture and agricultural science. Such training should receive the hall mark of a University degree when carried to a successful completion. In the progressive countries throughout the world, agricultural colleges of the best repute are being absorbed by the Universities and agricultural education is finding a place in the University syllabus. I see no reason why India should be an exception. Indeed, the time has come when it is very desirable to emphasise the high value of scientific technical knowledge by giving it the dignity of close association with the Universities in order to enable it to compete with purely literary education in the employment market for educated men.

At present our regulations demand of candidates for entrance to the vernacular course the possession of a simple acquaintance with reading, writing and arithmetic in Urdu (Upper Primary School), but these regulations are sufficiently elastic to permit of the admission of any suitable and serious students to this course. The University of the Punjab has just added the subject of agriculture (a paper and a practical examination) to the Matriculation Syllabus (1913). I understand that there is a growing demand for courses in nature study in the primary schools as soon as trained staff and funds are available. Such courses are eminently suitable for the training of country boys whose whole after-life will be passed in farming, and should equip them for higher training afterwards in agriculture either in the short vernacular classes or the higher University course—better than a purely literary schooling.

I think the time has come when the Agricultural Department should see how far it can join hands with the Education Department in forwarding such courses either by training men or by supplying inspectors when time and staff permit. This was indeed recommended by the 6th Board of Agriculture, which met at Pusa in February 1910, but no steps have yet been taken in this Province.

(d) The revision of the Curriculum for the Punjab Agricultural College.

At present there is a large amount of time devoted to the teaching of elementary science subjects in the Agricultural College at Lyallpur. Such subjects as elementary Chemistry, both organic and inorganic, the principles of elementary Botany, elementary Physics and Mathematics can be equally well taught by the existing colleges working under the Education Department where such colleges possess well equipped laboratories as is the case at Government College, Lahore. In teaching these subjects in the Agricultural College we overlap the work of that department and also absorb a considerable amount of time out of an already over-crowded and over-short course. A fair acquaintance with the elements of the above subjects before joining the Agricultural College will permit the student to devote more time to the technical application of these sciences and to purely agricultural subjects, and will lighten the course for him as well as permit of a higher standard being reached. It will in fact raise the teaching efficiency of the Agricultural College.

I anticipate that with this raising of the standard of entrance we shall only be able to secure sufficient scholars to fill the vacancies in the Agricultural Department in itself. If the diploma course is to be continued at Lyallpur, I advise the elimination of such subjects as Physics, elementary Mathematics, elementary Chemistry and Botany from the Syllabus of this College by the dual process of affiliating the College with the University and making a knowledge of these subjects conditional for entrance to the course of L. Ag. in a similar manner to that adopted in Medical Colleges.

A reference to the time-table of subjects taught in the Agricultural College at the end of the note shows that we shall effect a saving of some 16 hours now devoted to teaching elementary Botany and 13 hours devoted to elementary Chemistry and 11 hours to Mathematics and Physics in the first two years, making a total of 40 hours out of 99. If we recruit a type of student having a fair knowledge of the elements of science and we devote in all nine hours a week for two years to each of the subjects of Chemistry and Botany, we shall not only be able to teach these subjects in a more specialised and technical manner, but we shall have a further twenty hours of study per week to devote to the special agricultural subjects. The suggested time-table for the Punjab Agricultural College at the end of the note shows that by the elimination of these elementary science classes we can raise the time devoted to Agriculture from 31 per cent. to 48 per cent., Entomology from 4 to 6 per cent. and Agriculture Engineering from 1 to 3 per cent. In this manner the general standard of the whole of the important subjects taught there will be improved. These proposals are based on the past four years' experience and on the recommendations of the board of examiners for the diploma of L. Ag., Punjab, who in their reports for 1912 and 1913 have particularly noted on the poor knowledge of English possessed by the candidates, on their inability to apply their technical knowledge, and on the congestion and over-crowding of the examination subjects.

In addition to these changes in the standard curriculum now being taught in the Punjab Agricultural College a want is felt for organised instruction in the science of rural economy, and this is particularly needed for district officers such as assistant directors and the agricultural assistants working with them as well as for agricultural assistants working on the farms of the department. A course of this type has been recently started in the Berlin Agricultural College (Landwirtschaftliche Hochschule). It consists of instruction extending over two sessions and includes lectures in the following subjects which are supplemented by practical work in the College—

(1) The principles of national and communal administration.

(2) Rural administration.

(3) Civil Law.

(4) Finance.

(5) Insurance, social and private.

(6) Selected chapters of agricultural policy.

(7) Co-operation in its relations to agricultural organisation and present conditions of agricultural co-operation in Germany.

(8) The use of co-operation in agriculture; its principles, history and different forms.

(9) The technique of co-operative administration, including the administration of co-operative unions.

(10) The law of co-operation.

(11) The principles of commerce, the general principles of commerce and their application to rural economy. The principles governing wages, credit and stock exchange operations.

The stated object of the course in the above school is to qualify persons for entrance to the German Chambers of Agriculture or similar bodies, or for employment in large agricultural co-operative associations, etc., and to become the agents and managers of large estates or agricultural technical undertakings.

It will be difficult for such a college as the Punjab Agricultural College, with its diminishing number of students economically to support a properly qualified teacher of this science, but if there is any practical outcome of the suggestion of one central training college for India as indicated under my next paragraph, the inclusion of a professor of this science of rural economy on the staff of the College is of the utmost importance. The Agricultural Department in outgrowing its administration and its development is not proceeding uniformally in all its branches. In the Punjab, district organisation is handicapped for want of a properly qualified staff. The existing assistant staff have no working acquaintance with this science or any of the eleven branches indicated in the above course of instruction now being given in the Berlin Agricultural High School. Yet the subject of the best method of bringing the results of the Agricultural Department to the notice of the cultivator is perennial in the agenda of the Board of Agriculture. It is acknowledged on all sides that co-operation and co-operative credit offers the brightest prospect for educating and raising the agricultural masses in farming method, but no steps are taken to organise this most important branch of agricultural science by training the staff of the department to effectively secure its successful accomplishment.

(e) *Standardisation of the diploma of L.Ag. for India.*

There are many arguments in favour of standardisation of the diploma of L. Ag., but the principal one seems to be the expensive method of the present system of one college for each province irrespective of local demands. With the increasing facilities for inter-communication in the country, labour of all kinds will tend to flow to where there is most demand for it. In the course of the last four years we have had employed in the Agricultural College at Lyallpur graduates of the Calcutta, Allahabad, Bombay and the Punjab Universities. Given a uniform product in the shape of trained men from the Agricultural College, over-production in one school will lead to their seeking employment further afield and obtaining it. On the other hand, lack of uniformity will in the present state of India tend to attract students to those schools where education is cheapest, and a qualification can be most easily obtained. In the interests of the Indian farmer it is important that the Agricultural Department during its first years of existence should be staffed by thoroughly competent men in all branches of this service. For such provinces as the Punjab, where it is clear there exists no employment for the products of higher agricultural education save in the service of Government, one educational institute for several provinces would suffice for some years to come and indeed for many years, for it will be many years before education is so common in India that competent scientific agriculturists will have to find employment outside the services. In my opinion the machinery of agricultural education would have been more efficiently run with only one college for the whole of India and with research stations and experimental farms in each province. Such a college would be capable of training all the higher staff required in the Agricultural Department, and the provincial departments would then be free to devote themselves to vernacular education, to district work, and to collecting the large amount of information on the crops and conditions of India which can never be done by one research station. This does not in any way imply the abandonment of Pusa as a research institute, but rather the duplication of the staff there or elsewhere in the educational subjects. Duplication of staff will have to be effected in the Provincial colleges if useful research work is to be done there in addition to giving a diploma course of instruction, and with a limited demand for higher education it will be more economical to make one duplication than several. In those provinces where there is already a serious demand for this type of education and the number and quality of the licentiates warrants the expense of upkeep, the College might maintain its educational side working on exactly parallel lines to the Central Training College and with the same syllabus.

(f) *A Curriculum for Farmers' classes in the Vernacular.*

I append at the end of this note the syllabus of the six months' vernacular course of instruction in practical agriculture now being given at the Agricultural College at Lyallpur. This course has been modelled on what we consider the required course of instruction for the training of a farm sub-overseer. It is entirely practical in its nature and attempts to familiarise the student with actual method of improvement which experience has shown to be of value. It demands only the most elementary education, and indeed it is sufficiently simple and practical to be of value to an absolutely illiterate cultivator. Though I consider the vernacular course of instruction must be of a provincial or local nature and particularly modelled to suit the requirements of the province in which it is given, yet a comparison of similar courses given in other colleges and the experience gained there will be of great value to all in offering suggestions and widening our outlook.

(g) *Agricultural College staff.*

The agricultural side of the institute has to be entirely staffed by men trained there. If these men are engaged in teaching, and if they are not satisfactory in every respect, to use them for teaching work means we shall merely multiply their mistakes. The educational side of agriculture is too extensive for one man to carry it out unaided; a certain amount of the work must be deputed to his staff. It is necessary therefore to have thoroughly competent men, educated men and men with the necessary technical knowledge and experience on the staff to assist the professor.

In the teachig of elementary science, the Indian assistants have proved of great help, and as they gain experience can assume greater charge. They are, however, uniformally weak in the laboratory, and this is probably due to the Universities neglecting to recognise the importance of practical science as apart from theory and (nntil very recent times in this province) emphasising this in the allocation of marks in the examinations for science degrees. Indian assistants are used in the Punjab Agricultural College to teach such subjects as elementary Chemistry, elementary Botany, elementary Physics and Mathematics, Veterinary Science, Entomology, Surveying and for special courses and classes in Agriculture, including the vernacular course for the sons of zamindars. They cannot for the present be put in independent charge of such subjects as Agriculture, Agricultural Chemistry and Agricultural Botany.

Research.—The same applies to research work. So little attention has been paid to practical science in Indian education hitherto that there has not been in existence a class of men ready to enter the laboratory devoted to research work. Until very recently, even in such a widely taught science as Chemistry, it was impossible to obtain in this province a science graduate who on entering a laboratory had not to be taught the most elementary methods of detail. Accuracy of working was an unknown quantity. This means that research work in India requires the closest supervision by the head of the laboratory who must overlook each and every detail of the work of his Indian staff for the first few years. This close supervision and lengthy training is naturally irksome to the staff, and great difficulty is experienced in securing adequately educated men. For the scientific sections men of good education must be employed, and the pay and prospects must be such as to attract them, if this class of work is to expand. If they have some knowledge of agriculture, it will prove useful,

but it is not essential. There are no Indians in the Science Section who can at present stand alone and carry out this work unaided. I have an M. Sc. of the Punjab University working on a University research scholarship in the Chemical Laboratory. He is keen and has shown considerable ability in mastering the detail of manipulation and in abstracting the literature of the subject he is working on. If he can hold on for a few years, he should do well, and it is to be hoped that adequately remunerative employment will be found for him later on. This, however, is the great difficulty standing in the way of encouraging higher scientific education in India at the present time. There is no proper outlet for the product at the end of a long and expensive education; they find college contemporaries who have spent less in time and money holding more highly paid posts, and the scientific spirit is not efficiently alive in this country to secure votaries in the face of this.

(h) The question of forming a Permanent Educational Committee of the Board of Agriculture has been before the Board before. It was recommended by the Board, but did not receive the approval of the Government of India on the grounds that it tended to over-centralisation. I submit that the subject of Agricultural Education is of sufficient importance to merit a permanent place on the agenda of the Board of Agriculture, and that centralisation in its higher branches is at present desirable.

(i) The relative expenditure on teaching and research in the Punjab Agricultural College as is shown in Table No. XIII at the end of the note.

These figures are based on the estimate submitted by each expert, and have been compiled each year for inclusion in the provincial report of the Department of Public Instruction. It is a very difficult matter to obtain anything like reliable figures in such estimates as these, since a large proportion of the expenditure is necessary for both sections. A fairly accurate estimate, however, can be obtained by reference to the staff (shown in table No. XV). The cost of staff amounts to Rs. 53,923, of which Rs. 9,511 is entirely debitable to teaching, Rs. 40,152 partly teaching and partly research, and Rs. 4,260 entirely research. The remaining expenses of the College amounting to Rs. 44,354 is the expenditure on European and Indian stores, coal, oil, material for the workshop and the general running expenses of the College and are inseparable for the running of the institute whether as a research station or a teaching college:—

	Rs.
Total expenditure on the College in 1912-13	98,277
Consists of :—	
(1) Staff for teaching	12,587
(2) Staff for teaching and research	41,832
(3) Staff for research	5,100
TOTAL FOR STAFF	59,519
(4) Other expenses of the College, maintenance of laboratories, European and Indian stores, books, oil, fuel and gas, material for workshop, etc.	38,758
GRAND TOTAL	98,277
Income	11,739

Syllabus of the Vernacular Course at the Lyallpur College.

1. There will be a course of practical agriculture given in the vernacular every year for the sons of agriculturists, who have passed through the upper primary school course.

2. Boys between 16 and 20 whose fathers are actual cultivators will be preferred.

3. Applications for enrolment should be sent to the Principal of the College by August 1st.

4. The course will be from October 1st to December 20th and from February 1st to April 30th. Further training, especially in the interculture of cotton and maize, will be given during July and August if required.

5. About 20 boys will be taken each year.

6. The expenses of the course are :—

(a) Rupees 16 for the whole course as boarding house fee.

(b) Rupees 8 or Rs. 10 per mensem for food.

There are no other charges.

7. Six scholarships of Rs. 8 per mensem will be given. Other boys will be made to work as labourers on the farm, so that the training may be thoroughly practical, and they will receive an *inam* according to the value of their work. If possible, a month or so will be spent at Gurdaspur for study of barani cultivation.

8. The course will cover the following matters:—

(1) *Soils.*—Their composition, suitability for different crops; treatment of different soils.

(2) *Cultivation.*—Various methods, efficiency of hand labour (digging) and bullock labour (ploughing) compared. Object of ploughing, time of, methods of.

(3) *Implements.*—Different kinds of ploughs, harrows, sohaga, roller with special reference to the conservation of moisture; reapers, fodder cutters, etc.

(4) Seed selection.

(5) *Manuring.*—Preservation of manures, green manuring.

(6) *Water lifts.*—Capacity, cost, efficiency.

(7) Cattle feeding.

(8) Dairying.

(9) *Botanical.*—Sampling of seed, purity, germination, crossing, types of cotton and wheat.

(10) *Entomological.*—Life history of common pests, such as—

(i) Gram caterpillars,
(ii) Boll worms,
(iii) Grass hoppers,
(iv) Sugarcane borer,
(v) White ants,
(vi) Aphis.

and methods of combating these pests.

(11) *Veterinary.*—The common diseases of animals and their treatment—tumors and wounds in cattle.

STATEMENT No. I.—*Number of applications for entry to the Punjab Agricultural College, Lyallpur.*

Year.	No.	EXAMINATION PASSED.			
		B.A. or B Sc.	F.A. or F.Sc.	Matriculation Examination.	Others. (Including those who appeared at the Matriculation Examination.)
1909	709	3	53	572	81
1910	92	1	...	82	9
1911	89	...	1	72	16
1912	78	...	3	35	40
1913	40	...	1	33	6

STATEMENT No. II.—*Showing the occupation of fathers of candidates for admission into the Punjab Agricultural College, Lyallpur.*

Year.	GOVERNMENT SERVICE.		GOVERNMENT SERVICE. WITH LAND.		PRIVATE SERVICE.		PRIVATE SERVICE WITH LAND.		AGRICULTURIST.		Grand Total.	REMARKS.
	Total No. of candidates.	Percentage.	Total No. of candidates.	Percentage.	Total No. of candidates.	Percentage.	Total No. of candidates.	Percentage.	Total No. of candidates.	Percentage.		
1909	35	6·87	94	18·46	24	4·71	35	6·87	321	63·06	509	200 applications were not received on proper form, hence their occupation cannot be traced.
1910	8	8·65	25	27·17	6	6·52	11	11·95	42	45·65	92	
1911 . . .	15	16·85	24	26·94	9	1·11	6	6·74	35	39·33	89	
1912	6	7·69	24	30·76	4	5·12	4	5·12	40	51·28	78	
1913	3	7·5	15	37·5	1	2·5	3	7·5	18	45·0	40	

STATEMENT No. III.—*Showing caste and religion of candidates for admission into the Punjab Agricultural College, Lyallpur.*

Total No. of candidates.	PARTICULARS. Caste and religion.	Number.	Percentage.
	1909.		
709 . . .	Hindu	396	55·9
	Sikh	136	19·1
	Muhammadan	172	24·3
	Christian	5	·7
	N.B.—200 applications received late and not on proper form of admission.		
	1910.		
92	Hindu	46	50
	Sikh	22	23·9
	Muhammadan	23	25
	Christian	1	1·1
	1911.		
89	Hindu	39	43·8
	Sikh	29	32·6
	Muhammadan	21	23·6
	1912.		
78	Hindu	34	43·6
	Sikh	24	30·8
	Muhammadan	20	25·6
	1913.		
40*	Hindu	10	25
	Sikh	11	27·5
	Muhammadan	19	47·5

* None of these have joined the College.

Statement No. IV.—*Showing number of students on the roll of the Punjab Agricultural College, Lyallpur.*

Year.	Number with caste of students in the beginning of Session.			Number of students in the end of Session.
	No.	*Caste.*		*No.*
1909-10	16	Hindu	3	12
		Muhammadan	5	
		Sikh	8	
1910-11	35	Hindu	14	31
		Muhammadan	11	
		Sikh	10	
911-12	56	Hindu	25	49
		Muhammadan	17	
		Sikh	14	
1912-13	61	Hindu	26	53
		Muhammadan	17	
		Sikh	18	
1913-14	27*	Hindu	13	
		Muhammadan	8	
		Sikh	6	

* Diploma class 25

Casual students 2

Statement No. V.—*Showing caste, etc., of Vernacular class students.*

Name of class.	Number of students.	Caste of students.			Remarks.
		Hindu.	Sikh.	Muhammadan.	
Vernacular class	13	2	5	6	One boy did not appear in the last examination held in May 1913.

Statement No. VI.—*Detail of scale of pay in the Punjab Provincial Agricultural Service.*

No.	Post.	Pay.	Years.
		Rs.	
1	Assistant Director	300—10—400	10
1	Assistant Director	150—10—300	15
2	Agricultural Assistants	140—6—200	10
	2 house allowance	@ Rs. 15 each	
6	Agricultural Assistants	100—4—140	10
	6 house allowance	@ Rs. 10 each	
17	Agricultural Assistants	40—6—100	10
	17 house allowance	@ Rs. 7 each	
5	Assistant Professors	150—12-8-0—400	20
2	Teaching and Research Assistants	145—9—235	10
	2 house allowance	@ Rs. 15 each	
2	Teaching and Research Assistants	70—7—140	10
	2 house allowance	@ Rs. 10 each	
2	Research Assistants	145—9—235	10
	2 house allowance	@ Rs. 15 each	
2	Research Assistants	70—7—140	10
	2 house allowance	@ Rs. 10 each	
1	*Demonstrator*	75	Fixed.

STATEMENT No. VII.—*Showing present employment of Punjab Agricultural College Graduates.*

Number of students who passed the Diploma Examination from Punjab Agricultural College.	Number in Government employment in Agricultural Department.	In Government employment in other capacities.	Number who are actually farming or managing their own lands.	Otherwise employed.	Unemployed.	REMARKS.
16	10	...	1	2	3	

STATEMENT No. VIII.—*Showing present employment of Vernacular Class students, Punjab Agricultural College, Lyallpur.*

Number of students who passed through the vernacular course.	Number in Government employment in Agricultural Department.	Number in Government employment in other capacities.	Number who are actually farming their own lands.	Otherwise employed.	Unemployed.	REMARKS.
13	...	2	2	4	5	

STATEMENT No. IX.—*Showing requisition for services of Punjab Agricultural College Diplomates.*

Serial No.	Year.	From whom the offer was received.	Name of post or purpose for which required.	Pay.	REMARKS.
1	1911	Alwar State . .	Plantation work .	50—5—100	Required for a period of two years in the instance.
2	1911	Mr. H. P. Douglas, Barrister-at-Law, Bareilly.	Person knowing agriculture required; purpose not stated.	Pay not given.	
3	1912	Sardar Amar Singh, Nazim, Patiala.	Manager of lands .	Ditto.	
4	1912	Lala Madho Ram, Tahsildar, Patiala.	...	Ditto.	
5	1912 . . .	Lala Amrit Lal .	Tutor in Agriculture	Ditto.	
6	1912	M. Partap, Esquire, Almora.	Manager, farm .	Rs 75 per mensem.	
7	1912	Botanical Forestry and Scientific Department, Uganda (Africa).	Supervision of native labour.	Rs. 100	£80 a year to £130 with house accommodation and medical attendance with free quarters.
8	1912	Imperial Economic Botanist, Pusa.	Fourth Assistant .	75—10—125	
9	1913	Aitchison College, Lahore.	Professor knowing agriculture preferred.	80—4—100	
10	1913	Imperial Agricultural Research Institute, Pusa.	Second Farm Overseer.	60—8—100	
11	1913	District Board, Ambala.	Superintendent, Arboriculture.	60—75	By triennial increment of Rs. 5 and Rs. 10 fixed travelling allowance.
12	1913 . . .	Faridkot State	Science teacher .	...	

Statement No. X.—*Showing number of hours allotted to each subject in one week in the Punjab Agricultural College, Lyallpur.*

Name of class.	Botany.	Chemistry.	Veterinary Science.	Land Revenue.	Land Surveying.	Entomology.	Agricultural Engineering.	Agriculture.	Mathematics.	Physics.
3rd year class	(*a*) 9	(*b*) 6	4	...	...	1	1	(*a*) 13	...	...
2nd year class	(*a*) 7	(*c*) 6	4	12 lectures only delivered in autumn term.	12 lectures only delivered in autumn term.	3	...	(*a*) 12	...	...
1st year class	(*a*) 9	(*c*) 7	...	...	...	...	...	(*c*) 6	4	(*a*) 7
Total	25	19	8	...	...	4	1	31	4	7

Includes (*a*) 3 hours for lectures.
„ (*b*) 1 hour „ „
„ (*c*) 2 hours „ „

N.B.—Total of 99 hours per week or average of 33 hours per week for each class.

Statement No. XI.—*Suggested time-table for the Punjab Agricultural College, Lyallpur.*

Name of class.	Botany.	Chemistry.	Veterinary Science.	Land Revenue.	Land Surveying.	Entomology.	Agricultural Engineering.	Agriculture.
3rd year	...	...	...	...	...	...	3	30
2nd year	9	9	3	24 lectures in all	during the year.	3	...	9
1st year	9	9	3	...	...	3	...	9
Total	18	18	6	...	...	6	3	48

N.B.—These figures give approximate percentage of time devoted to each subject in the course.

Agriculture	48	per cent.
Agricultural Chemistry	18	„
„ Botany	18	„
Veterinary Science	6	„
Land Revenue and Surveying	1	„
Entomology	6	„
Agricultural Engineering	3	„
Total	100	

Statement No. XII.—*Comparision of time devoted to each subject in the course now given at the Punjab Agricultural College, compared with the proposed alterations.*

Subject.	Present course.	Proposed course.
Agriculture	31 per cent.	48 per cent.
Chemistry, including Agricultural Chemistry	19 „	18 „
Botany, including Agricultural Botany	25 „	18 „
Veterinary Science	8 „	6 „
Physics	7 „	...
Mathematics	4 „	...
Entomology	4 „	6 „
Agricultural Engineering	1 „	3 „
Land Revenue and Land Surveying	1 „	1 „
Total	100	100

STATEMENT No. XIII.—*Showing total expenditure incurred during the past five years.*

Year.	Total expenditure.	Allotted.		Percentage.		Remarks.
		Research.	Education.	Research.	Education.	
	Rs.	Rs.	Rs.	Rs.		
1908-09 . . .	60,022	College not	opened.			
1909-10 . . .	95,240	14,348	(a) 80,892	15·1	84·9	
1910-11 . . .	90,564	20,343	(a) 70,221	22·5	77·5	
1911-12 . . .	92,517	20,250	(a) 72,267	22·0	78·0	College turned out eight graduates in 1911-12.
1912-13 . . .	98,277	20,453	(a) 77,824	20·8	79·2	College turned out eight graduates in 1912-13.

(a) Includes pay of whole establishment.
N B.—This statement of expenditure excludes the cost of buildings.

STATEMENT No. XIV.—*Showing income of the Punjab Agricultural College, Lyallpur.*

Year.	Amount.	Remarks.
	Rs.	
1908-09	307	
1909-10	794	
1910-11	3,818	
1911-12	8,290	
1912 13	11,739	
1913-14 (estimated)	12,700	

Statement No. XV.—*Showing staff engaged in teaching and research in the Punjab Agricultural College, Lyallpur, on 1st October 1913.*

Serial No.	Subject.	Education.	Pay per mensem.	Education and research.	Pay per mensem.	Research.	Pay per mensem.	Remarks (Grand Total).
1	2	3	4	5	6	7	8	9
			Rs. A. P.		Rs.		Rs.	
1	Chemistry .	Bh. Jagat Singh, Assistant Professor of Chemistry.	175 0 0	Mr. J. H. Barnes, Agricultural Chemist, Punjab.	800	Mr. D. K. Ambekar, Research Assistant.	77	
		Muhammad Nasir, Lecture Table Assistant.	46 0 0	2 Peons at Rs. 7 each	14	Bh. Arjan Singh, Research Assistant.	77	
		Mahbub Ali, Laboratory attendant.	12 0 0	1 Chowkidar at Rs. 7	7	Mr. Barkat Ali, Research Assistant.	77	
		Narain Din, Laboratory attendant.	12 0 0			One Research Assistant, vacant.	...	
		Demonstrator, vacant.	...			Jagat Ram, Laboratory attendant.	10	
						Fazal Quadir, Laboratory attendant.	13	
		Total .	245 0 0		821	...	254	
2	Agriculture .	Bh. Kharak Singh, Assistant Professor of Agriculture.	187 8 0	Mr. W. Roberts, Professor of Agriculture.	650			
		Sandhi Shah, Mukaddam.	19 0 0	2 Peons at Rs. 7 each	14			
				M. Mukhtar Nabi, Teaching and Research Assistant.	84			
		Total .	206 8 0		748			
3	Botany .	L. Jai Chand, Assistant Professor of Botany.	150 0 0	Mr D. Milne, Economic Botanist.	750	Zahir-ud-din, Mukaddam.	19	
				A. Yusaf Ali, Teaching and Research Assistant.	84			
				Rawai Chand, Laboratory attendant.	13			
				Sant Ram, Laboratory attendant.	12			
				2 Peons at Rs. 7 each	14			
				1 Mali at Rs. 25 .	25			
				1 Under-Mali at Rs. 10.	10			
				1 Teaching and Research Assistant, vacant.	...			
			150 0 0		908		19	

N. B.—The farm staff under the Professors of Agriculture and Botany are not shown in this statement.

STATEMENT No. XV—*continued.*

Serial No.	Subject.	Education.	Pay per mensem.	Education and research.	Pay per mensem.	Research.	Pay per mensem.	REMARKS (Grand Total).
1	2	3	4	5	6	7	8	9
			Rs.		Rs.		Rs.	
2	Entomology .	...	...	L. Madan Mohan Lal, Assistant Professor of Entomology.	175	Muhammad Ali, Mukaddam.	16	
				Dalip Chand, Laboratory attendant.	10		...	
				One Teaching and Research Assistant, vacant.	...	*Ram Chand, rearer and setter.*	18	
						4 Field men at Rs. 12 each.	48	
				Total .	185	...	82	
5	Veterinary Science.	M. Muhammad Abdulla, Veterinary Assistant.	30					
		Total .	30					
6	Physics and Mathematics.	Vacant . . .	...					
7	Land Surveying.	Pt. Mulk Raj .	Yearly 25					
8	Land Revenue	Mr. Salisbury, I.C.S.	Sanction for an honorarium of Rs. 100 per annum applied for.					
9	Agricultural Engineering.	Vacant . . .	...					
10	General .	Principal, Punjab Agricultural College.	100					
				L. Ram Lal Head Clerk.	80			
				L. Kashi Ram, Accountant.	47			
				L. Des Raj, Record-keeper.	35			
				M. Abdul Ghani, Store-keeper.	44			
				M. Hussain Ali, Librarian.	35			
				L. Gopi Chand, Typist.	22			
				L. Dev Raj, Typist .	20			
				Pt. Mohan Lal, Diarist and Despatcher.	30			

Statement No. XV—*concluded.*

Serial No.	Subject.	Education.	Pay per mensem.	Education and research.	Pay per mensem.	Research.	Pay per mensem.	Remarks (Grand Total).
1	2	3	4	5	6	7	8	9
			Rs.		Rs.		Rs.	Rs.
10 *concld.*	...	...	...	M. Bostan Khan, Museum and Harbarium Keeper.	24			
				One peon . .	7			
				One chaukidar . .	7			
				One tent-pitcher .	7			
				One sweeper . .	7			
				Three sweepers at Rs. 6 each.	18			
				One bhishti . .	7			
				Total .	380			
				Workshop.				
				Pt. Chandu Lal, Head Mistri,	64			
				M. Borkatulla, Fitter.	40			
				M. Nabi Bux, Carpenter.	34			
				M. Sultan Muhammad, Engine Driver.	34			
				M. Sawaya Ram, Fitter Blacksmith.	34			
				Ghulam Rasul, Gasman	12			
				Hakim Din, Hammerman.	20			
				One Chaukidar . .	7			
				Two coolies at Rs. 9 each.	18			
				Total .	263			
				Road and Garden Staff.				
				Balla Singh, Mali .	21			
				Two under-Malis at Rs. 10 each .	20			
				Total .	41			
		Boarding House.						
		Superintendent .	25					
		Bearer . . .	8					
		Bhishti . . .	7					
		Two sweepers at Rs. 6 each.	12					
		One chaukidar .	7					
		Total .	59	...	684			
	Grand Total	...	9,511	...	40,153	...	4,260	53,923

APPENDIX—E.

(3)

Subject IX.—Note on the proposed alterations in the course at the Agricultural College, Coimbatore.

(D. T. Chadwick, M.A., I.C.S., Director of Agriculture, Madras.)

The present course extends over three years and is based on the recommendations passed at the Conference at Pusa in 1906. The laboratories, especially the chemical laboratories, are arranged to accommodate 20 students in each year; and consequently, the number admitted in each year has, as a rule, been restricted to 20. The first batch of students entered at Coimbatore in 1908. The following table shows the number of applications, etc.:—

Year.	Number of applications for admission.	Number admitted.	Number of those who ultimately obtained the diploma or are still at the College.	Remarks.
1908 . .	82	18	14	Passed out after three years' course.
1909 . .	92	14	10	
1910 . .	146	20	12	
1911 . .	101	18*	9 in IIIrd class.	* Excluding the two students selected by D. P. I.
1912 . .	84	20	15 in IInd class.	
1913 . .	80	20†	20 in Ist class.	† Excluding two students for special course.

Until 1913, selection from applicants for admission was made by the Principal on a consideration of:—

(i) The educational qualifications of the candidate.

(ii) The status of the applicant's family.

Preference was, as a rule, given to those from whose antecedents it appeared probable that they already were directly connected with agriculture.

(iii) The Districts from which they came.

As there is only one agricultural college in the Presidency and there is work to be done in every district it was inadvisable to fill the College always with boys from only a few districts. Especially is this the case as in Madras there are four main vernacular languages all possessing entirely distinct alphabets, etc. In 1913 the boys were selected after a short preliminary examination.

2. The majority of the successful diplomates have joined the Agricultural Department and, as far as can be judged in the short time they have been in it, promise very well. But

(i) It has been necessary to refuse admission to the majority of applicants;

(ii) there has been heavy wastage from amongst those selected.

3. Although the large majority of the students ultimately accept Government service, either in Madras or in one of the Native States, there are a few who have returned to their land or estates. Viewed from a purely Departmental point the work of the Agricultural Department is being retarded by the slow rate of recruitment.

4. The course at present is the same for everyone and most of the instruction in Agriculture takes place in the last year. Experience has shown that many of the students find the science which they meet in the first two years difficult. Inability to cope with it has formed the chief reason for wastage. The difficulties which arise through having to deal with classes composed of boys of uneven intelligence are also experienced. It is doubtful whether those who wish to return to their own estates need to be put through the full science course as now arranged. In the departmental staff above the status of the trained maistry there is room for three types of men:—

(a) The man with full practical training and some scientific knowledge who would do for the work in the districts—pushing recognised improvements.

(b) The man fully trained practically but also possessed of better scientific and general attainments capable of managing farms and carrying out, under direction, experimental work thereon and of controlling the former class of men. The best of these would, it is hoped, ultimately rise to Gazetted posts.

(c) Assistants in the Science Sections. These have at times to go into the districts and it is desirable, generally speaking, that they should always have gone through an agricultural course though at times science graduates from the University may be preferred. If teachers in Agriculture are required later in Training Schools, etc., they would be drawn from Class (b).

5. At present, an attempt is made to turn these three types of men out of the same mould. From

(i) a recognition of the needlessness of putting everyone through the same course,

(ii) a desire to meet more fully the numbers of applicants, and

(iii) a desire to obtain more generally intelligent classes for instruction in the sciences, and

(iv) a perusal of reports on Agricultural Education in countries other than England,

the scheme which has been detailed below was worked out.

6. Briefly it proposes to divide the full course in two, of which the first two years will be devoted to agriculture both on the farm and in the lecture room and the last two years will be given mainly to the sciences connected with agriculture. Where the lectures fit in the first two years some of them will be given by the officers of the Science Sections, but the agricultural aspect will be the point that will be insisted upon and there will be little practical experimental work in the laboratories by the students in the first two years. A much more complete scientific course is given in the 3rd and 4th years. Boys up to some 40 or 50 could be taken for the first two years' course and those

successful in the examination at the end thereof would be given a certificate. Those who obtained this certificate and who

(*a*) entered the College originally with *higher general educational qualifications* (*which it is* hoped may be fixed by the help of the Educational Department) and

(*b*) those who not possessing these qualifications originally yet succeeded in passing, at the end of their first two years, an examination in English, Arithmetic and one or two general papers of sufficient difficulty to justify their proceeding for the advanced course (here again it is hoped the Educational Department would help us) would be free to proceed for the 3rd and 4th year courses up to their diploma.

7. If this scheme were accepted the departmental staff would require regrading.

8. The commencement of the College year at Caimbatore (June) coincides with that of the local Agricultural year. The lectures in the first year will be arranged to follow the practical work on the farm which will follow the seasons. Thus lectures on manures will be given by the chemical staff during the period of manuring the fields, on soils during the first period of preliminary cultivation. In the first year practical work on the farm will occupy every morning in one fortnight and every afternoon in the next. In the second year the boys will cultivate their own plots and be split up into sections for training in rotation in the dairy, in Veterinary and Carpentry work, control of oil-engines, etc., in cattle-feeding and seed-store, in Botanic garden (grafting, budding, horticulture) *and special field work, e.g., use of special implements.*

9. In the 3rd and 4th years, Agriculture will only occupy about one day a week.

10. A draft curriculum is appended.

11. By this arrangement it is hoped

(*a*) that the College *will prove of greater general utility*.

(*b*) that those who come chiefly for practical training will obtain it without hampering the students who are taking an advanced course.

(*c*) that the final science classes will be of a higher level in intelligence than at present and will progress more rapidly.

Syllabus for first year, viz., Agriculture.

Throughout the year in one fortnight there will be field classes and practical work on the farm in the morning, in the next fortnight this practical work will take place in the afternoon. The lectures will be arranged as follows:—

Time.	Work which will then be in progress on the farm.	Number of lectures possible during this period.	Distribution of lectures and officer giving the lectures.	LECTURES
1st period .	Preliminary cultivation on the farm .	40	The Agriculturist : dealing with soil moisture in the soil, tillage, ploughs, harrows, rollers, etc.	16
			The Chemist who will deal with soils, etc.	4
			The Entomologist	3
			The Botanist	6
			The Mycologist	3
			The Educational officer who will deal with English and Arithmetic (if necessary for any)	8
2nd period .	Manures and manuring . .	20	The Agriculturist : Farm yard manure, storing, etc., green-manuring and fertlisers	6
			The Chemist	6
			The Botanist	4
			The Educational Officer : English and Arithmetic where necessary.	4
3rd period .	Seed and sowing .	10	The Agriculturist : seed bed sowing, drilling, etc.	5
			The Botanist	4
			The Mycologist	1
4th period .	Weeding and after cultivation . .	45	The Agriculturist : transplantating, weeding, boring, irrigation, etc., watering, drainage, rotations, mixtures, pastures	18
			The Botanist	9
			The Zoologist*	9
			The Educational Officer { Physical geography	5
			The Educational Officer { Mensuration	9
5th period .	Harvesting . .	20	The Agriculturist : Harvests, various crops and harvesting implements, seed-selection	6
			The Botanist	2
			The Educational Officer, Field survey	12
6th period .	Threshing . .	20	The Agriculturist : Threshing various crops and preparing produce	7
			The Educational Officer : Survey class work (takes time)	10
			The Botanist	3
7th period .	Storing and marketing. . . .	15	The Agriculturist : Stacking, storing, Farm Machinery	6
			The Engineering Assistant, Building material and construction	9
	TOTAL .	170		

* Several officers will come in.

In the second year agriculture again—work on the farm will only be undertaken on alternate days and then will largely consist of cultivation by the students of their own plots. On other days they will be on special work for which they will be divided into four sections. One section will be engaged in dairying, another in veterinary work and manual work, another on cattle food and seedstore, and another in the Botanical gardens and special farm work.

Manual labour connotes instruction in carpentry, control of oil engines, etc.

Special Farm work means use of particular improm its, *e.g.*, disc plough. After a fortnight each section will move on one. The 170 lectures will all relate directly to agriculture but will be divided approximately as follows:—

Agriculturist and Veterinarian—dealing with the care and sickness of animals, the dairy, breeding, housing animals, etc.	42
Chemist—dealing with the dairy and feeding of animals	7
The agriculturist on special crops	10
The Botanist on special crops	16
The Mycologist on the more important diseases of crops	10
The Entomologist on the more important pests of crops	10
The Engineering Assistant on surveying	20
General lectures on forests, their object, etc., rents, etc.	20
Tours (2 of a fortnight)	20
Holidays	15
	170

Third and Fourth Years.—The course is that prescribed in the first two years in the present curriculum but the time given to Agriculture will be reduced and will then be mainly revisional and as the boys will have been especially selected it is hoped that further and more rapid progress will be made in these sciences than has hitherto been possible.

APPENDIX—E.

(4)

Subject IX.—Statement showing the present position of the Teaching work at the Sabour Agricultural College.

(E. J. Woodhouse, M.A. F.L.S., Dip. in Agri., Principal, Agricultural College, Sabour.)

1. *Government policy with regard to the College.*—The policy of the Government with regard to the College was laid down in a resolution No. 770 of February 1910 in which the following sentence occurs:—"The training in the College is not intended to provide an avenue to the Provincial and Subordinate Executive Services and that Government will not recognise the agricultural degree as a qualification for appointment to those services or for the managership of an estate under the Court of Wards." It will be seen therefore that the College was intended to train those who wished to take up agriculture as a paying business, and was intended solely for a training ground for the Department's staff.

2. *Admission of students into Diploma Course.*—In selecting students for admission into the first session of the College care was taken by Mr. Dobbs to impress on each candidate that Government service was not guaranteed to successful students. Since then, this policy has been continued and all applicants for admission are informed that Government service is not guaranteed to passed students of the College, but they are expected to make use of their knowledge in farming or in the management of private estates. The figures for admission give a good indication of the relative popularity of Government service and private enterprise. In 1910 there were 550 applications for 20 vacancies, but these were reduced to 190 when it was understood that there were no prospects of employment outside the Agricultural Department. Eventually 24 students were admitted, of whom two were wards of Government. In 1912, 39 applications were received for vacancies and 12 students entered the College. In 1913, 31 applications were received for 40 vacancies and 6 students, including two scholars, eventually joined, of whom two students and one scholar have since left. A large proportion of the applicants only desire Government service, and on being informed that such employment is not guaranteed to passed students they immediately find that family or other reasons prevent them from attending the College.

3. *Reasons for the failure of the College to attract students.*—The figures for admissions show clearly that the College has steadily decreased in popularity since it has been realised that it is not likely to be an avenue to Government service. The absence of any demand for agricultural education can be ascribed to numerous causes. First as regards the artificial demand caused by appointments in Government service:—

(1) The diploma given by the College is of no value as a qualification for service outside the Agricultural Department; in 1910 the applications were reduced from 550 to 190 when this was made known.

(2) No statement has ever been made as to the number and pay of the appointments that are likely to fall vacant in the cadre of the Agricultural Departments of the Provinces concerned, so that there is no encouragement for prospective candidates for such posts to attend the College.

In the absence of any definite proposals for appointments in Government service the guardians of prospective students must naturally consider very carefully the prospects of employment which are likely to result from the three years spent in obtaining the diploma. Such prospects of employment can only be of two kinds: (*i*) private service under landholders as land-stewards or farm managers, or (*ii*) farming.

A few applications for men to fill posts of land-stewards have been received and such applications always lay stress on the fact that experienced practical men are required. It is not likely that the demand for this class of men will increase until passed students of the College have proved their mettle. The fact that Government refuses to employ them in khasmahals and estates under the Court of Wards does not tend to encourage other landholders to do so.

In coming to the question of the possibilities of farming as a profitable occupation for the educated middle classes, we have reached the crux of the problem. I have talked over this question with many people competent to judge regarding it and the general concensus of opinion would appear to be that under the conditions brought about by the permanent settlement it would be extremely difficult for a man to become a tenant farmer on a large scale, and a zamindary manager or owner would not be able to make adequate profits from the cultivation of his scattered khas lands. It must also be borne in mind that a farmer who had undergone an expensive education would expect to be able to realise sufficiently large profits to enable him to maintain a position befitting his education. To do this he would require considerable capital and it is extremely improbable that this will be available in the case of a young man of the class under consideration. Again, upto the present, a sufficiently large body of fact has not been collected to prove either that capitalist agriculture can be made to pay or to show what system of agriculture should be employed.

4. *Defects in the education provided.*—It may be assumed that the first essential to any scheme of scientific or technical education is a sufficient groundwork of fact. It appears, however, that this principle was lost sight of, when it was decided to open the Sabour Agricultural College without adequate preliminary investigation with the local agriculture and the methods of improving it. This mistake has been accentuated by the fact that in Bengal and Bihar the experiment stations have been multiplied without an adequate complement of Expert Officers being provided to work them efficiently. The result has been that there has been no large body of information available on which to found a course of instruction, and there have been no successful demonstrations such as would encourage the cultivating classes to attend the College to learn improved methods of agriculture.

The next essential in technical instruction is a really Expert Instructor. In the case of an Instructor in technical agriculture a man would be required with a thorough knowledge of local conditions round the College and a general knowledge of the conditions throughout the province. It is also important that during the elaboration of a course of instruction, there should be no alteration in the staff, as such alterations prevent continuity of policy and any profit being derived from any mistakes made. At Sabour these requirements have never yet been secured. Three Officers have been in charge of the agricultural work since the opening of the College in 1910. It has also happened that each of these Officers has disagreed to some extent with the educational policy pursued by his predecessor.

Remedies suggested.—With a view to remedying these defects it has been suggested that the European District Staff should be largely increased, that a qualified and experienced Agriculturist be obtained who would be likely to continue in charge of the College work at Sabour for some time to come. The following alterations were suggested in the courses of instruction given in the College:—

(1) In the first place recruits can be provided to fill vacancies in the scientific sections and to meet any private demand by offering post-graduate courses in such subjects as Agricultural Chemistry, Plant-breeding, Horticulture and Fruit Farming, Economic Entomology. Only a very limited number of students in any one subject would be taken yearly, but they would work directly under the eye of the head of the section in his research laboratory. Only students with a sound grounding in science with particular reference to the subject concerned would be admitted. The course would probably be complete in one year.

(2) The second course would be a technical course in agriculture, including horticulture, for the benefit of would-be farmers, land-stewards, etc. Very little science would be taught and that would be taught on nature study lines. The duration of the course would be reduced to two years if possible; it would probably have to be given in English on account of the number of languages spoken in the provinces concerned, but a vernacular course of the kind would probably prove more attractive. Students who pass through this course should make useful farm managers and land-stewards and should be suitable for all the general work of the Department.

It will be seen that the above scheme would avoid the waste of time involved in the teaching of an excessive amount of pure science in order to remedy the defects in the elementary education of the students, and the reduction in length of the course would enable us to deal with a larger number of students.

(3) Besides these two courses there would be a series of short technical courses for the benefit of cultivators. These courses would either last for some time, *e.g.*, the present *bhadoi* and *rabi* course, and so would enable the cultivators to see any improved technical methods in use during that season, or they would deal with special subjects, *e.g.*, dairying, *eri* silk or lac cultivation, use of Rajah plough, horticulture, etc. If necessary, Instructors may also be sent out from Sabour to give certain of these short courses elsewhere.

The above account of the present position of the education work at Sabour is summarised from a statement of the case submitted to the Director of Agriculture in July 1913.

A Committee meeting to discuss the reorganisation of the College work was subsequently held at Ranchi in September 1913, at which were present the Secretary to the Government in the Revenue Department, certain Members of the Patna University Commission and the following officers representing the Agricultural Department, Mr. Milne, Mr. Dobbs and myself. At this meeting the Agricultural Officers expressed the view that the College at Sabour should be closed until such time as local and scientific investigation and demonstration should have created a demand for technical and agricultural instruction. They did not think it economical to keep the College open for the purpose of training subordinates for the Department alone as the small staff likely to be required at present could probably be better obtained from existing Colleges and trained by the Officers concerned.

In case, however, it was decided to use the College as a training College for the subordinate staff of the Department the Committee recommended that ten students should be admitted yearly for the next few years, five appointments in the Department being guaranteed yearly. By the end of this period the investigation work of the Department might have advanced sufficiently to have created a genuine economic demand for a practical course of instruction. The Committee also considered that the initial rate of pay of the subordinates should be raised from Rs. 40 to Rs. 50 per mensem and the Entrance standard should be raised to the I. Sc. standard; in admitting candidates preference should be given to the sons of agriculturists, and in case they were not forthcoming it might be advisable to assist them through their school course by means of scholarships. The above proposals for the training of the scientific staff and for short demonstration courses were approved, and the question of the most suitable Diploma course was held over until after the forthcoming meeting of the Board of Agriculture. It was not considered advisable to affiliate the College to the Patna University.

APPENDIX—F.

Subject X.—Note on Dairying in India.

(S. MILLIGAN, M.A., B.Sc., AND C. M. HUTCHINSON, B.A.)

The following note has been prepared with a view to providing a basis for discussion by the Board of Agriculture. It is the result of tours made by the anthors in the course of which typical dairies, both under European and Indian management, were visited. The letters received from Directors of Agriculture in the various Provinces and Native States in which the local treatments of the question of dairying is dealt with, with varying degrees of fullness, would form valuable appendices to this note. The general conclusion arrived at may be said to be that the present condition of dairying in India is thoroughly bad, but that, although this is largely due to antochthonous causes, much might be done by Government to improve it. Suggested lines of action are made in the note,—for discussion by the Board.

The main recommendations we desire to lay before the Board for consideration are:—

(1) The necessity of early steps being taken by Government to secure the best milking animals in the country.

(2) That the investigation of the inheritance of the important dairy characters of cows by crossing with imported bulls be undertaken by the agricultural Department.

(3) We recognise that the improvement of the Dairy Products of the country will be mainly achieved through the agency of Municipal bodies and Co-operative Societies and that steps should be taken to study the Bacteriological aspects of Dairying under Indian conditions at Pusa.

I.—Supply of Dairy Products.

Dairy Animals.—In spite of cheap fodder and food grains, cheap labour, and the absence of sanitary regulations, the prices of Dairy Produce are at least as high in India as they are within a few miles of London. This fact can be wholly accounted for by the poor milking qualities of the Indian Dairy animals, and the Dairy Industry, if it may be so called, suffers more from the insufficiency of its milk producing machinery than from any other cause. There is little authenticated information on actual milk yields in this country, but all authorities are agreed that the average of even the best breeds of cows does not exceed 2,400 lbs. per lactation period, and that of buffaloes 3,600. What the general average of the sum total of the cows and buffaloes in the country is, may be left to the imagination. It is sufficiently apparent that Dairying in India is in an unhealthy state, and that there is little hope of its improvement until something has been done to improve the milking capacity of the cattle.

Improvement of Milking Qualities.—It is fairly obvious that an increase in the milk yield of a dairy animal represents approximately a similar increase of revenue, the additional feeding necessary to support the increased yield being a small percentage of the total. Where butter making is the main objective a high percentage of butter fat is desirable and Indian dairy animals are in general strong on this point. For milk supplies the principal consideration is quantity, provided the percentage of butter fat does not fall below a reasonable amount. According to the experience of people who are in the habit of buying large numbers of dairy cows and buffaloes it is becoming increasingly difficult to obtain good milking animals. Although it is unlikely that within recent years the general milking capacity of cows has deteriorated from natural causes, there is little doubt but that the town dairies are producing a serious drain on the best milking cattle in the country. The percentage of good milkers amongst Indian cattle is so small that this may in the end bring about serious results. The question of the preservation by Government agency of the best milking cows in the country is therefore an urgent one. In addition it is important that steps should be taken at an early date to improve the milking capacity of at least the cows and if possible the buffaloes, by selection or crossing.

The main objection to selective improvement is the length of time which must necessarily elapse before results can be obtained. The utter absence of pedigree and the consequent difficulty of obtaining sires for use in the herds makes the question one of the greatest difficulty. For example the Pusa herd of the Sahiwal cows has been in existence for over 8 years. The cows were carefully selected and fresh blood has been introduced annually. Out of nearly 200 cows which have been in milk during that period we have only had three really good milkers. We have not as yet succeeded in breeding one first class milking animal. The Department of Military Dairies had ransacked the Punjab for good Sahiwal cows and their proportion of good milkers is somewhat similar. It is therefore apparent that improvement through selection will be a long and difficult task and it seems certainly worthwhile to carry out crossing experiments with imported sires from good dairy breeds. The Military Dairies have already shown the way through the introduction of Ayrshire blood into their milking herds and have so far as they have gone, been quite successful. A scientific study of the inheritance of the important characters of dairy cattle by crossing might lead to valuable results. This could be undertaken at Pusa with a certain amount of help by the Provincial Agricultural Departments in the way of using imported or half-bred bulls on those farms where milking herds are kept.

Milk supplies for the cities.—This subject has received considerable attention from the Municipalities of some of the large towns in India. Owing to the perishable character of milk and the absence of sterilizing plant the cities draw their supplies from cows kept inside and a few miles outside municipal boundaries. This fact, added to the comparative inefficiency of the dairy animals as milk producers, has the effect of keeping prices for pure milk at a high level. It is doubtful whether pure cow's milk is ever obtained at a lower rate than 5 seers to the rupee in the large cities: milk sold at lower rates is almost invariably watered. It is also doubtful, owing to the economic conditions under which it is produced whether pure milk can be sold at an appreciably cheaper rate.

Control of the milk supply in towns.—Although the milk trade appears to be in a deplorable condition the present arrangements cannot be unduly interfered with until an alternative organisa-

tion for the supply of milk has been built up. It thus seems desirable to introduce healthy competition from outside where the cost of production is considerably less. With reasonable facilities in the way of transport, it is possible that this could be accomplished. The Military Dairies have shown that milk, after pasteurizing, can stand a 14 hours railway journey across one of the hottest parts of India.

The question of *adulteration* of milk does not come within the scope of this note. It is, however, worth considering whether the demand for cheap milk and therefore watered milk by the poorer classes could not be met by a supply of pasteurized skim milk from the country, the bye-product of ghee or butter factories.

The most important milk product is *Ghee* or clarified butter which is manufactured throughout India. Being thoroughly sterilized in the process of manufacture it keeps for long periods and is thus much more suitable than butter for a hot country. It is largely produced from the milk of buffaloes. The process of preparation is well known and need not be described here.

Commercial ghee is much adulterated with fats and oils and it is difficult to obtain pure ghee in large towns.

Butter is of course largely made throughout India being the first stage in the manufacture of ghee. Although the main commercial product is ghee, there is nevertheless a considerable demand for butter *owing probably to the difficulty of obtaining pure ghee.*

Tinned butter is now largely produced in Gujerat (Bombay Presidency). In spite of the absence of a ready market for the separated milk the trade in tinned butter has developed considerably and the product is used all over India, Burma and the Strait Settlements. The introduction of the cream separator some years ago has had a great deal to do with the development of this industry. The cream is separated in the villages and sent to large centres like Bombay and Ahmedabad where the butter is made and tinned. In the case of Bombay, the cream ripens on the way and is ready for churning when it arrives at its destination. The whole process is carried out under the most insanitary conditions. Still the trade is firmly established and its success is a testimony to the value of an efficient piece of dairy machinery where conditions demand rapidity in handling the produce.

The use of the separator in ghee and butter making would probably prove of advantage owing to the great superiority of separated over skim milk.

II.—*Methods of Handling.*

From the Bacteriological standpoint, the treatment of milk may be considered from three points of view:—

(*i*) The presence of organisms causing deterioration in quality;

(*ii*) The presence of pathogenic organisms;

(*iii*) The presence of organisms causing deterioration of milk products such as cream and butter.

The importance of securing, so far as possible, the absence of such deleterious organisms does not require emphasis here, but it is worth while to point out that no advance can be made in dairying in this country until the absolute necessity of proper dairy technique has been realised by those engaged in this pursuit. This is all the more so in view of the fact that the average air temperatures in India approximate much more closely than those in Europe to the optimum for multiplication and physiological activity of such bacteria as occur in, and produce harmful results to, milk and its consumers. Numerous and frequently repeated experiments in Europe and America have demonstrated clearly one important and fundamental fact, namely that the success of various processes of *sterilization or semi-sterilization*, such as *Pasteurizing*, both in increasing the keeping properties of the milk and in ridding it of pathogenic organisms, depends almost entirely upon the original bacterial content of the milk when brought into the Dairy for treatment; this original content itself depends upon the method of milking and the conditions under which it is carried out, and further upon the methods of handling the milk in transit to the dairy. These conditions in Europe are *strictly regulated by careful dairy-men in response to the public demand for pure milk and to* Government or Municipal regulations enforced by local inspectors. In India there is no such demand from the Indian consumers nor legal compulsion to back it, if it existed. Only the European community requires or demands pure milk and in the numerous localities where no dairy under European supervision exists, the milk is boiled by the consumer to ensure the destruction of the deleterious organisms *which may be assumed to be present.*

Attempts have been made in some towns, such as Calcutta, to obtain better conditions for drawing the milk from the cow; in this city municipal milking sheds were erected and the *gowalas* invited to use them free of charge, but the attempt was a failure, principally owing to the unwillingness of the latter to put themselves to the inconvenience of bringing their cows to the sheds. Nothing but legal compulsion is likely to overcome this difficulty, and a further one arises involving the necessity of paying for the cost of supervision, always high in India if effective, and at the same time of meeting the demand for cheap milk. Not only do the numbers of bacteria eventually found in milk after passing through the dairy depend largely upon the conditions of milking, during which operation the milk is exposed to infection from particles of dust, manure, dried urine and other sources, but the eventual composition of the bacterial complex will be largely determined by the character of the infection taking place at this period, any large number of organisms of one species gaining entry at this time, obtaining an advantageous start resulting in their eventual predominance. The quality of the milk both with regard to its keeping power and suitability for con*sumption, or production* of cream and butter, thus depends very largely upon the conditions under which it is drawn, and therefore the first step towards improvement must be in this direction. It seems hopeless to pursuade the Indian cowkeeper to milk his own cows under sanitary conditions; the Indian consumer makes no demand for milk which is pure either in regard to absence of deleterious organisms or to freedom from adulteration with water, and in the absence of such demand no *unnecessary trouble will be taken to avoid either contamination or the profits resulting from* adulteration. Only in towns where public feeling is created by an enlightened minority and given expression to by municipal action, is it possible to make use of preventive measures to ensure the provision of milk of better quality, and even then such attempts may be frustrated by the refusal of the cowkeepers to submit to control, as in the case of Calcutta. Here Government intervention seems called for, but the immediate danger appears to *be a possible rise in the price of milk and a reduction* in the supply. In many localities, especially in and around large towns, the profits from the sale of milk are small and depend largely upon adulteration; were municipal supervision introduced, involving not only the expenditure of more time and trouble on the part of the cowkeeper, but a possible reduction in his opportunities for adulteration, many of the latter might give up milk production altogether. The remedy for this seems to be the introduction of better milking breeds, the provision of grazing grounds and winter fodder, and the organisation of collection and transport. There can be no doubt that in time the gradual interaction of demand by the enlightened minority and action by municipalities and local Governments, will create a public feeling in favour of better milk and gradually raise the standard of popular demand. Then dairies run by Indian

proprietors will want to know how to produce pure milk and good butter, and it will be necessary to provide the information; at present we are dependent upon European experience, which, as in many other cases connected with Agricultural operations, requires very serious modifications to enable it to be of practical utility under Indian conditions. It may be repeated here that temperature plays a most important part in the development and physiological actions of bacteria, and *as the question of milk condition and keeping power depends almost entirely upon bacterial action* it is obvious that a thorough knowledge of the bacteriology of milk under Indian conditions is necessary for successful work in dairying in this country, where air temperatures during most of the year approximate to the optimum for bacterial action and development. High class dairying in India is mostly carried on under conditions which demand the supply of large quantities of milk and milk products, but do not afford opportunities for original work on bacteriology by those in charge of such establishments. It is more than probable that the high temperatures obtaining in the plains of India affect the complicated bacterial reactions taking place in milk in such a way as to introduce serious differences between them and similar changes at the lower temperatures of Europe; it is possible that investigation might show that methods which are best in temperate climates may be modified with advantage or even superseded by very different ones, in India.

Such investigation would naturally be included in the work of the Agricultural Department; whether the time has arrived for its inception is a question to be decided in relation to the more practical problems now under consideration.

So far as manufacture of butter is concerned, enquiry both in Bombay and Bengal indicates that the consumption of this milk product is largely limited to the European community, and *although large quantities are made in Bombay, mostly from cream imported by rail from the* Ahmedabad and Surat districts, this is distributed over India for European use, or else exported to other countries such as E. Africa, Burma and the Straits. Butter is not likely to displace Ghee as an article of consumption by Indians, for various reasons, one of which is the inherent keeping capacity of the latter due to the prolonged high temperature incidental to its manufacture, another scarcely inferior in importance, being the possibility of adjusting its market price to the requirements of various grades of purchasers, by means of adulteration with such substances as sesamum oil, coconut oil and animal fat; in addition to these two reasons a third exists in the prejudice against butter as an article manufactured under conditions which may have brought it under the ban of religion or caste. It appears, however, that there is a growing demand for butter amongst Indians not for consumption as such, but to be used for the manufacture of ghee; this is referred to in the note by Mr. Joshi on ghee manufacture. It is also interesting to note, as an instance, of the possibility of extending the use of dairy products in India, that the Khasias, whose Mongolian proclivities preclude the use of cow milk as such, purchase condensed milk of European manufacture for feeding their infants and children.

The application of bacteriological research to the manufacture both of butter and ghee in this country would take the form first of general enquiry as to the best methods of securing the absence of deleterious organisms, as in the case of milk itself, and more specially, the isolation and culture of such organisms as are most suitable for the "ripening" of cream. Such cultures are known as "Starters" and are in universal use in European and American dairies, the quality of butter depending upon their purity and suitability in the same way as that of beer does upon properly selected yeasts. In India the use of starters imported from Europe has not been a success, even in dairies under European supervision, partly owing to the difficulty of avoiding contamination, and partly, no doubt to the unsuitability of the imported strains to Indian conditions.

From the point of view of the European consumer, therefore, it is probable that butter making in India might profit by research work on bacteriological lines. It is also possible that improvements in the making of ghee might result from such work, but the latter depends so much more, as a commercial article, upon careful blending with adulterants, that it would probably be a waste of time to deal with its manufacture from this point of view.

Sterilization of Milk.—This process in the various dairies visited is carried out entirely on lines elaborated in Europe or America, and it is assumed that the organisms present in milk are similar in India to those found in the former continents, and can be controlled or eliminated by similar treatment. *This is a large assumption and savours of empiricism in dealing with an industry which owes* its success in Europe entirely to scientific investigation on bacteriological lines. As an instance of the use of what appears to the writer a method highly unsuitable for use in India may be cited the apparatus for cooling during the process of Pasteurization, in which the milk is spread in a thin layer completely exposed to the air; were it desired to reinfect the milk with the greatest number of air-borne bacteria possible in a given time, this method would admirably serve the purpose. It is also customary to assume, as has been already pointed out, that the standard technique of sterilization as practised in European Dairies is the best possible for India. It is necessary, however, to remember that this technique does not aim as a rule at the complete removal of all micro-organisms but endeavours to exterminate the directly pathogenic species, such as those of tuberculosis and typhoid, and to keep down the number of the others so that at the comparatively low temperature to which the milk is reduced after heating these latter may not multiply with sufficient rapidity to produce harmful results. Such a method of treatment depends almost entirely upon starting with comparatively clean milk, and being able after heating to keep the partially sterilized products at a temperature at which the surviving organisms will not multiply rapidly. Such conditions are easily obtained in Europe, but very difficult to procure in India, and it would seem necessary to revise the whole technique of sterilization in this country with a view to modifying it in accordance with local conditions.

It would also be necessary to include an enquiry into the conditions under which toxic bodies are formed in milk by bacterial action before sterilization, which operation, although it may prevent further formation of such substances, does not remove or destroy them. It is a question to be considered by the Board whether such enquiry would come into the province of the Agricultural Department or be more properly relegated to that of medicine.

APPENDIX—G.

(1)

Subject XII.—Note on the Fruit Trade of the North-West Frontier Province.

(W. Robertson Brown.)

The following remarks are based on the results of experiments conducted at the Peshawar Agricultural Station where there are 40 acres of peaches, plums, apricots, grapes, quinces, pomegranates, figs, pears, oranges, limes, etc. Mangoes and other less hardy fruits which readily suffer from frost are not grown.

Cultivation.

Planting.—Young trees, set out with substantial soil balls, gain great advantage over trees of equal age which are planted without earth attached to their roots.

December and January are the best months in which to plant deciduous fruit trees. Oranges and trees which are green during the cold season, transplant most successfully in February.

Irrigation.—Where basin, ring, or furrow irrigation is practised, the bottoms of the furrows crack, and soil moisture escapes excessively. In the early life of an orchard, irrigation on the flat is more satisfactory, if the flow of water is confined to strips of land down the lines of the trees, and the surface of the soil is afterwards cultivated by the Planet Junior Hand Hoe. The land which is not occupied by the roots of the trees may be covered by a low growing leguminous crop, such as "moth" (Phaseolus aconitifolius). In mature orchards the cover crop may be grown over the entire area, and irrigation confined to strips of land suitable to the spread of the trees.

Although it is undoubtedly true that orchards which are irrigated by wells and streams yield the best crops, excellent results are obtained at Tarnab by the careful use of canal water, and it is probable that the general unthriftiness of canal irrigated orchards is caused by the use of *excessive* quantities of water.

Inter-cultivation.—Where ploughing is possible in an orchard, the country plough seems to be as suitable as any steel implement, and light digging is more economical than ploughing in an orchard of developed bush or half standard trees.

The Single Wheel Planet Junior Hand Hoe is efficient and economical in cultivating an orchard which has not a trailing cover crop.

Intercrops.—In the early life of an orchard, low growing vegetables are suitable intercrops where there is a convenient market for the produce. On land which is distant from a market, gram or barley or *masur* may be grown in Winter, and "moth" most efficiently shields the land in Summer.

Green Manuring.—"Moth" as an orchard cover-crop yields excellent results when it is dug into the soil in November, and it is advisable to let the land lie fallow during the four succeeding months. On average orchard land, fruit trees are greatly benefited by generous mulchings of decaying vegetable matter and burned refuse.

Pruning.—Although peaches, plums, and apricots are much improved by judicious pruning, it is not possible to do the work economically on extensive plantations, as skilled labour is rarely available in India and the season during which pruning is possible is short. Removing the branches which crowd the hearts of the trees and lopping a few of the lower branches which threaten to sweep the ground are generally as much pruning as can be profitably carried out.

Insect pests.—Peach and plum orchards, however, thoroughly cultivated, are subject to the attacks of green fly, and the trees must be sprayed to preserve them in health. The "knapsack" and the "bucket" sprayers are effective in small gardens, and orchards of more than 4 acres extent require larger sprayers.

White Ants (Termites) kill or injure as many as 5 per cent. of the trees in many peach and plum orchards, and although incinerator dust and wood-ashes are used with moderate success in checking the pests, a really effective method of meeting their attacks has not been found.

A practical method of dealing with the grapevine leap hopper (Typhlocyba comes. Say.) would be appreciated by grape growers.

Diseases.—Gumming (Cladosporium epiphyllum) on peaches, plums and apricots is the most serious disease which affects the orchards of the North-West Frontier Province, and attacks are encouraged by fruit dealers, who strip leaves from the trees for packing the fruits.

Windbreaks.—Bamboos, large sour limes, or loquats are useful orchard windbreaks, but shrubs or small trees are of little avail when dust storms sweep over the land during the fruiting season. A few lines of pigeon pea (Cajanus indicus) planted throughout the orchard, shelter young orange and lime plants and encourage them to grow freely.

Propagation.

Local Varieties.—Occasional trees are found in the old orchards of India which produce distinctly superior fruits, and some of the varieties which have been discovered in the North-West Frontier Province are equal in all-round merit to the imported kinds.

Imported Fruit Trees.—The stocks which are used for fruit trees in Europe and America are not always suitable foster parents under Indian condition, and it is therefore advisable to plant imported trees in the nursery for the production of buds or grafts, which may be inserted on the stocks which are suitable to the District. Disease which may appear on the imported trees is more readily observed in the nursery than in the orchard.

Imported varieties of fruits, like agricultural crops generally, are not successful until they are acclimatised, although it is sometimes possible to hasten acclimatization by budding or grafting.

Stocks.—Experiments in the uses of various stocks promise valuable results at Tarnab, and plants are being studied in the nurseries and orchards. The following are some of the trials which are now in progress:—

1. Peach, on plum and peach.
2. Plum, on plum and peach.

3. Apricot, on peach, plum and apricot.
4. Pear, on wild pear, quince, and cultivated pear.
5. Orange, on large sour lime, small sour lime, citron and pummello.
6. Grape vine, on various hardy grapes.
7. *Apple, on country apple, English paradise and French paradise.*

In each of the above it is also desired to ascertain whether budding or grafting gives the best result, and which of the numerous methods of grafting and budding are most satisfactory. It is thought that some choice European fruits may be induced to bear freely when their behaviour on stocks in India is better understood.

The following are a few of the conclusions arrived at in trials of stocks at Tarnab, where the soil is chiefly deep sandy loam:—

1. The small sour lime produces the most vigorous Malta orange-trees.
2. The "sweet lime" is the best stock for the loose-skinned *sangtara* orange.
3. The plum is unsuitable for the peach.
4. The seedling peach is the best stock for the peach.
5. The plum is unthrifty on its own roots, or on the country plum (Prunus cerasifera), but it is vigorous and bears early on the seedling peach.
6. The pear on Pyrus Pashia does not yield early.
7. The quince promises to be a suitable stock for the pear.
8. The apricot does well in the valleys when it is budded on the seedling peach, and on the foot hills it is most profitable when grafted on the seedling wild apricot.

There must be great store of knowledge in India on the questions of fruit stocks, and the subject is worthy of systematic study.

Nurseries.—Indian nurseries almost invariably consist of small, irregular, and weedy plots, and the young fruit trees which are sent out by nurserymen are poorly grown.

The European method of laying out, cultivating, and planting nurseries is followed at Tarnab and Haripur, cuttings, stocks and seedlings being set out in long openly spaced, straight lines, which are intercultivated and weeded cheaply and rapidly by the Planet Junior Hand Hoe. Men are being trained to take up nursery work on the lines practised at Tarnah.

Distribution.—Pending demonstration of the market value of the varieties of fruits which are grown at Tarnab, nursery stocks have been distributed in the North-West Frontier Province, free of all cost, but it is hoped that men will soon take up the nursery business and relieve the Agricultural Stations of distribution work.

Marketing.

Fruit picking.—Light step ladders are useful aids in picking a small proportion of the fruits on bush or half standard trees, but bare-foot nimble Indian boys safely gather the bulk of the crops without the aid of ladders.

Fruit room.—*The greater part of the fruit crop of the North-West Frontier Province is picked* at early dawn and packed before the heat of day sets in, and this practice is convenient and suitable in small gardens. A fruit room is rarely necessary, even in a very large orchard, as selected fruits *which* are to be sent by rail are promptly conveyed to the cities and packed by the dealers. Fruit rooms are liable to become dirty and they are not infrequently used as lumber-rooms.

Growers' Returns.—The sum of Rs. 800 was offered for the crop of 2 acres of 3 years old peaches on the Peshawar Agricultural Station in the year 1913, but the average price per acre of peaches in the district is at present Rs. 200, and this sum leaves a fair margin of profit to the fruit growers. In the first and second years of the life of a peach orchard, the intercrop should almost meet the cost of planting and cultivation, and treatment during the succeeding years consists of the annual digging, and the thinning of the branches and the fruits, with periodical weeding and irrigation. Apricots, plums, grapes, pears, quinces, and several other fruits are as profitable as peaches.

Dealers' Returns.—The following figures present the value of peaches in the Peshawar market, based on the results of the trials conducted at the Agricultural Station during the past year.

When *set out at 20′ × 20′ apart, an acre of land carries 108 trees,* each of which is estimated to carry one and a half maunds of peaches from the fourth to the tenth year of its life inclusive. The fruits of first quality average 6 ounces in weight.

Value of the Crop of an acre of peaches in Peshawar Fruit Market.

	RS.	A.	P.
54 maunds of 1st quality peaches (11,808 fruits) @ 2 pice per fruit	369	0	0
54 maunds of 2nd quality peaches @ 1 pice per fruit	184	8	0
54 maunds of 3rd quality fruits @ Rs. 2 per maund	108	0	0
TOTAL	661	8	0

The above is a moderate estimate of the value of a crop of the Tarnah varieties of peaches which have been selected for propagation. Each tree carried over 2 maunds of good peaches in its third year of orchard life, and the officers' messes of the North-West Frontier Province gladly paid Re. 0-1-0 per peach, while Re 0-2-0 were freely offered by the clubs and messes of distant stations. No part of the crop was sold at less than Rs. 4 per maund.

Packing.—In the North-West Frontier Province a useful trade in high class fruits is promised, but the profits of the fruit growers must chiefly depend on the larger trade in cheap fruits. The Peshawar fruit dealers have good business acumen, and if their methods of packing are not good, it may be in a measure because it does not pay to pack more expensively. They deal in foreign fruits, and good methods of packing are constantly brought to their notice.

Fruits which are sent by growers for sale in distant stations must frequently remain unsold on fruit stalls for some days, and on this account it must always be necessary in India to pack fruits for the trade when they are distinctly unripe and to leave a considerable margin to the dealers to meet the losses which are frequently caused by damage to the fruits in transit.

Various types of boxes and baskets were tried at Tarnab during the past season and many hundreds of dozens of peaches and plums were sent by road and rail to distant parts of India. The conclusions arrived at are as follows:—

1. The locally made "*pilchi*" (*Tamarix dioica Roxb.*) baskets which are used by fruit dealers are suitable for the general fruit trade.
2. "Arhar" (Cajanus indicus) baskets, to carry 5 seers, are suitable for the private fruit trade.
3. Quetta non-returnable boxes are useful for special consignments of fruits.
4. Wood-wool, when made from silver fir (Abies Webbiana), is economical and efficient packing material for all fruits.
5. Very few fruits are bruised in baskets when wood-wool is skilfully used.

The following statements give the comparative cost of peaches packed in boxes and baskets:—

For the Trade.

In Basket.

	Rs.	A.	P.
(1) 2 pilchi baskets at Re. 0-2-0 each	0	4	0
80 1st quality peaches at two pice each	2	8	0
Carriage of 2 baskets of fruits from Peshawar to Calcutta at Re. 1-1-0 per seer basket	2	2	0
Packing, paper, wood-wool, etc., at Re. 0-3-0 per basket	0	6	0
TOTAL	5	4	0

In Box.

	Rs.	A.	P.
(2) One Quetta non-returnable box	2	0	0
96 1st quality peaches at 2 pice each	3	0	0
Carriage from Peshawar to Calcutta	3	3	0
Packing	0	1	0
TOTAL	8	4	0

When the value of the 16 extra peaches which the box carries is deducted, the two baskets still yield Rs. 2-8-0 more than the box to the Calcutta dealer. Eighty peaches at Rs. 5-4-0 are better value than ninety-six peaches at Rs. 8-4-0.

For Private Trade.

	Rs.	A.	P.
(1) One 5 seer basket	0	1	6
18 1st quality peaches at Re. 0-1-0 each	1	2	0
Carriage from Peshawar to Calcutta	0	8	6
Packing, paper, etc.	0	1	0
TOTAL	1	13	6
(2) One Quetta crate	0	9	0
20 peaches at Re. 0-1-0 each	1	4	0
Carriage from Peshawar to Calcutta	0	8	6
Petty charges	0	0	6
TOTAL	2	6	0

Eighteen peaches @ Re. 1-13-6 are better value than twenty peaches at Rs. 2-6-0.

The large non-returnable box cannot be used to carry fruits without the punnets, while the baskets on the other hand, are suitable for the conveyance of all kinds of fruits, and besides serving many useful general purposes, they can be uesied and returned when a number are collected.

Basket making is a useful local industry around Peshawar, and the supply of pilchi is unlimited.

There are several objections to the use of "san fibre" in fruit packing, and chief among these are the (1) high cost, (2) unattractive appearance, (3) distinctly unpleasant smell. It has also been pointed out that "san" is retted in foul water. Wood-wool, on the other hand, is pleasing in appearance, and antiseptic in nature, and when made of silver fir, it is almost odourless.

Fruit Growers' Association.—It is proposed to form a Fruit Growers' Association at Peshawar in April 1914, the primary objects being to (1) improve the fruits, (2) secure fair prices, (3) improve railway facilities.

APPENDIX—G.

(2)

Subject XII.—Note on Fruit Culture in the Central Provinces.

(A. E. Lowrie and R. J. D. Graham, M.A., B.Sc.)

The cultivation of fruit in the Central Provinces has been hitherto, one might almost say, quite neglected. A few gardens around Nagpur, with an area of, at the most, 700 acres, and isolated patches in Khamgaon, Damoh and one or two other districts grow oranges; in all about 1,000 acres. To this if we add 1,500 acres under guavas and, at the most, another 300 acres under plantains scattered in small areas throughout the Provinces, we sum up the whole of the fruit-producing area of the Provinces. This excludes small private gardens where a few fruit trees are grown and also the mango groves which are mainly planted as camping grounds.

The fruits are put on the market anyhow and not on any regular commercial basis. That is to say, no care is taken in removing the fruit from the trees, thus injuring and lowering the commercial value, and very little is done in the matter of grading the fruit before it reaches the market.

Cnsidering the growing of fruit in the Central Provinces under systematised conditions, one has not the slightest hesitation in saying that the indnstry can be made a great commercial success for such fruits as all kinds of citrus, mangoes, guavas, custard-apple, pine-apple, peaches, plums, plantains and papaya. To attain this the undertaking only requires to be well pioneered. No better suggestion could be made for carrying this out than to follow, more or less, the methods adopted for the cultivation of orchards in Southern California, where fruit-growing, specially for the citrus, has been brought to a high degree of perfection. The conditions of Southern California are taken because they are the best suited to those in India. There is a large area in the Central Provinces where fruit-growing can be very profitably carried out, the fruit from which would supply not only the Provinces, but also the Indian markets outside the Provinces, where at present so very little fruit is seen.

The growing of the different kinds of fruits and localities best suited for them will now be taken up.

The Citrus fruit.—The Nagpur orange is the best known orange grown in India, and tradition has it that a better orange cannot be grown than that found round Nagpur; this is a fallacy. The fruit is a very loose-jacketed tangerine and when well grown is above the average size of this class of orange. It is in Bombay that one generally hears of the Nagpur orange, which is brought to the market and sent all over India, but it must be remembered that the bulk of the fruits that come to the market at Bombay as Nagpur oranges is grown in and about Poona.

Orange-growing at Nagpur has been known for many years. In one or two places it is carried on with a certain amount of care, but on the whole a great want of any systematic management is evident. The trees for the most part are badly grown. Fertilization is almost *nil* and when carried out consists of a little farm yard manure applied to the roots direct. The better groves are ploughed now and again to keep down weeds. Irrigation is carried out by means of a single furrow along the base of each row, with the trees directly in the furrow. Owing to this the bases of the trees are always standing in water while the irrigation is going on. The irrigation is carried out every 5 to 7 days during the warm dry season. Only budded stock is used, but almost in every case no care is taken in growing the stock for the purposes of budding. The time for gathering the main crop is November and December, but besides this a second crop is forced on in April. This is produced artificially by removing the soil from a part of the root system, giving the tree a great shock, which brings about an extra period of blossoming. The roots are exposed for about a month during which water is withheld, after this the soil is filled in and the trees are heavily watered and in a short time the blossoms appear and the fruit matures about April. This off-season crop in April is highly appreciated, but it is certain that the trees cannot stand this shock year after year and must deteriorate. It is most probably due to this that the average Nagpur orange, as grown round and about Nagpur, has deteriorated a good deal from what it used to be 20 years ago.

Besides this the other citrus fruits grown are the "Kágzi" lime, grown for the most part in gardens which have a few trees. Little or no care is taken of these trees, and they are left to grow as best they can, even watering being seldom done.

Except at local markets in the Provinces during the season this fruit is not dealt with commercially.

Next come sweet limes, pomelo and citrus. These are held of little account and are only seen in gardens, whence a few are brought to the market. The oranges grown in the other districts are all of the tangerine type, and evidently come from Nagpur stock.

A few hints of what might be done in improving this industry.

This industry under good systematic management can be pioneered into a great commercial undertakiug. The districts proposed for the growing of oranges and other citrus fruits are the following:—Nagpur, Chhindwara, Jubbulpore, Damoh and Amraoti. Regarding Chhindwara, soil from this district was taken to Southern California, the home of systematic orange-growing, and was there analysed. The analysis showed the soil to be quite equal to their best citrus soils, except a slight deficiency in phosphates and magnesium. Nagpur, Chhindwara and Jubbulpore are the three districts where the orchards should be started under good systematic management which would include fertilization, irrigation and cultivation. The point always put forward against the loose-jacket tangerine is that it is very liable to injuries and cannot stand travelling any long distance. There is no reason why this should not be remedied by carefully cross-fertilising it with some of the imported scions such as the Washington Novel, Jaffa, Malta and other seedless varieties. Then, again, for India the aim is to get a good orange, other than an off-season one, during the months of April, May and June, when this fruit is most appreciated. For this careful cross-fertilising with the Valencia and late Valencia will have to be made. These Valencia oranges ripen in California during May, June and July. Besides the improvement of oranges, the growing of lemons on a commercial standing will be taken up. There is no doubt that lemon-orchards will pay handsomely in a very short time. The improvement of the "Kágzi" lime, which is largely used in the manufacture of lime juice and citric acid, should also receive attention.

The improvement of the pomelo as now grown in India is also worth attention, and to this the growing of the Florida and South California "grape fruit," a pomelo less than half the size of the fruit one sees in India, will be taken up. This "grape fruit" is a fruit which has only got to be known to be appreciated.

The improvement of citrus and sweet limes should also receive attention.

The Mango.—This fruit has received a certain amount of attention in these Provinces, but on no commercial scale. Most owners of gardens have a few inarched mango trees in their gardens, which receive no particular attention, the fruit when ripe being auctioned to local contractors who hawk them about the station. *Once the plants have established themselves, say after the fourth or* fifth year, little or no care is given them. This well known fruit deserves attention. The kinds best adapted to certain areas should be studied and plantations on a commercial basis should be started at Chhindwara, Nagpur and Jubbulpore. Little is done in grafting and this should be taken up. The indigenous stock grows so fast that after a year or two this should be a simple matter for trees where the stock has been grown from seed in plantations.

The Guava.—This fruit is grown all over the Provinces, and being a hardy tree receives at present very little attention, except a few waterings during the time the fruit is ripening. It can hardly be said that this fruit is grown on any commercial scale. It ripens during the cold weather months, the fruit staying on the trees some time. Two crops are at times obtained by watering during the hot weather months soon after the first crop has been gathered; this gives a small crop during the rains. Much remains to be done in improving this fruit and growing it on a commercial scale. Plantations should be started in Nagpur, Jubbulpore and Chhindwara, and improved varieties obtained from without the Provinces to work from in the plantations formed. Once improved methods are adopted, there is no doubt that all districts will take it up, as it is the easiest grown fruit.

Pine-apples.—This is a fruit which can only be grown over a very limited area in the Province with any commercial success. In the Raipur Government garden a small area has now been grown year after year, and produces fruit of most excellent quality, equal to the best that can be grown in India. The growing of the pine-apple in Raipur has not received quite the attention it might have had, and since there is no lack of manure there and water soon to be had, the cultivation of this fruit is a simple matter, and should be taken up in the district of Raipur on a commercial scale. The soil best suited for it is a certain quantity of black soil mixed with laterite, free drainage and ample manuring and watering. Varieties other than that now grown in Raipur should be tried on selected localities easily watered.

Peaches and Plums.—With the exception of a very small area at Pachmarhi the growing of this fruit has been neglected. Peaches and plums of a very fair quality ripen at Pachmarhi, but other *than this, there is unfortunately very little to go on for extending plantations, so as to produce* fruit on a commercial scale. Judging from soil and climatic conditions in Chhindwara, which have been compared with those of Southern California, there seems not the slightest doubt that under proper systematic culture these fruits can be well grown here. At present there are at Chhindwara a few and, one may say, uncared-for trees that fruit very well. This in itself is encouraging, showing that with care the fruit could be well and profitably grown.

Grapes.—The great arguments against grape-growing in these Provinces are that the fruit ripens after the rains break. Here again Chhindwara on the plateau is the most hopeful place for growing this fruit. The climatic conditions are good and the rainfall during an ordinary year somewhat less than other districts of the Provinces, except some of those in Berar and Khandwa where the climate is not well adapted for this fruit. Regarding Khandwa it may be mentioned that to within a few years a fair quantity of grapes were grown below the Asirgarh Fort, and sent to the Bombay market. True the fruit was sour and not worth eating, but this was only due to bad varieties and want of systematic cultivation. Under systematic culture the cultivation of this fruit should be taken up at Chhindwara and at Khandwa where it was grown before; as regards some other districts, varieties where the fruit would ripen early should receive attention.

Figs.—This fruit could be well grown in the plateau districts of Chhindwara, Betul and Seoni. *Judging from the few plants one sees in gardens it is well deserving of attention. Selected varieties* should be obtained and given systematic cultivation. Experiments should be made to graft on a hardy stock. The fig commonly grown is *Ficus palmata*.

The Custard-apple.—The easiest grown fruit of the Provinces where the trees grow. It is at present entirely neglected, but is one quite deserving of a maximum of attention to improve the delicious fruit, which ripens in September and October.

The Plantain.—The growing of this fruit has been somewhat attended to of late years, but much remains to be done to grow it on a commercial scale. At present nearly all the fruit one sees *in the markets or hawked about in the stations* of the Central Provinces comes from either Bombay or Calcutta. There is no reason why this should be, as the plantain grows well in the Provinces, and only requires care and attention in growing it to make it pay. Selected varieties of improved kinds should be introduced into the Provinces and worked up in regular plantations. Systematic fertilizing and irrigation are two of the main points required in growng this fruit in trenched plantations.

Other fruits.—The growing of other fruits grown in a tropical and semitropical climate should not be neglected.

Papaya.—This fruit grows well and easily in the Provinces and is quite deserving of attention and systematic culture.

General Remarks.

The systematic culture of mangoes, guavas and citrus fruits, including experiments in irrigation and fertilization, will be started at Nagpur, similar experiments will be made with pine-apples at Raipur, while at Chhindwara the cultivation of all the fruits, with the exception of pine-apple, will be started.

The formation of co-operative societies has added very largely to the success of fruit-growing in California, and there is no reason why a similar institution should not be attempted in these Provinces. District co-operative fruit-growing associations, with a selected head-office for general advice and working, should be aimed at, and one sees no reason whatever, judging from the strides made in agricultural education in the Province during the last few years, why this fruit-growing association for the Provinces should not be a success in a few years.

Markets for fruits.—It is absurd at present to go for Nagpur oranges to the Bombay market, and not to Nagpur as a centre. This must be aimed at, especially now that a good market-place is *being built at Nagpur.*

APPENDIX—H.

Address to the Board of Agriculture at Coimbatore by Mr. Arno Schmidt, Secretary of the International Federation of Master Cotton Spinners' and Manufacturers' Associations.

I am extremely obliged to you for the opportunity you have given me to address to you a few remarks as to the views taken by the Cotton Spinners of the world regarding the extension and improvement of cotton cultivation in India. Our books and pamphlets describing what is being done in other countries in this respect have been sent to most of you, but I fear, as is usually the case, only few have had time to study them. This opportunity, therefore, of addressing those who are in the main responsible for the development of the cotton-growing industry in India is all the more valuable to me.

To those who are not acquainted with *the aims and objects* of the International Federation of Master Cotton Spinners' and Manufacturers' Associations let me explain that it is a Federation of Millowners' Associations in *all* the countries of the world, wherever Indian cotton is used, and that it protects the common interest of the cotton spinners and weavers of the world. The predominating common interest is of course the increase in the supply of the raw material and this accounts for my repeated visits to India.

The Cotton Industry of the world has been suffering, as you no doubt know, from *a scarcity in the supply of the raw material.* This scarcity has frequently been so pronounced that mills in all countries have been obliged to stop working for certain periods and at this present time a reduction of the working hours of the cotton mills in several continental countries has been commenced, and Lancashire will discuss the advisability of running short time during this month. The primary cause for this reduced output, is the fear that the world's supply of cotton will not be sufficient to last out the season owing to the deficiency in this year's American crop. The opinion is held by my Committee, and I may say by every expert who has studied the question, that India alone is the country that can come to the immediate rescue of the cotton industry in this, I might say, perilous position.

Let me explain in a few words the *possibility of extension of cotton growing in other countries.* At one time the hope was entertained that *Africa* would solve the problem, but after about 8 to 10 years' work in that Continent, it has been proved beyond doubt that in consequence of the requisite training of the people, of the scarcity of population, of the absence of proper transport facilities, of the necessarily slow work of scientific research and of the apathy of the people to work longer than is necessary to keep their few wants satisfied, development in those parts must be slow and perhaps the next generation will be able to reap what has been sown by the present one. Far be it from me to deprecate the efforts made by the various colonial cotton growing associations; their work is excellent and will undoubtedly be of benefit to the cotton industry in say 20 to 25 years. The gentlemen from across the Herring Pond, as the citizens of the new world are fond of styling *the Atlantic Ocean, have often assured us that there is no need for the cotton industry to look* elsewhere than to the *United States* of America for our increasing requirements of cotton. To this I have to say, firstly, that it is unwise to put all one's eggs into one basket. It is utterly uncommercial to have to rely upon the vagaries of a climate, which judging from the alarming reports issued every year seems to be the most critical climate in the world. Secondly, I can assure you, *on good authority, that the cotton states of the United States are suffering severely from lack of* labour and I am informed by several experts who have recently visited the American Cotton Belt, that in 1911 when the crop of the United States reached 16,000,000 bales, much more was grown but it had to be left to rot in the fields because there were no people to pick it. We may therefore justly assume that, although the yield per acre is increasing in the States, yet the limit of the cotton crop of America has been reached. Moreover, the people of the United States have to contend with a very formidable scourge, *viz.*, the boll-weevil, which keeps spreading and will, in about five years, have reached the Sea Island cotton producing district. As long as no efficient mechanical cotton picker is invented, and so far the results achieved in this direction are not worth considering, the cotton crop of the States is never likely to exceed 16,000,000 bales. Even with the advent of an efficient mechanical cotton picker, few planters would be able to afford such a machine, for you know that the tendency in the States is to split up the large plantations into small holdings, and the small farmer has not the capital to invest in these machines, which will necessarily be expensive. Other suppliers of cotton are some of the Republics of South Africa, but they are short of agriculturally trained people and of means of transport. Egypt is limited in its cotton crop by the small area that can be cultivated, and although Lord Kitchener is doing his utmost to reclaim land, yet in comparison to the world's requirements the possibilities of this new tract are insignificant. Egypt produces now 1,000,000 bales of 700 lbs. and any increase in the crop must be slow and cannot possibly be more than half a million bales, and for this at least 10 years will be required. We are, therefore, bound to fall back upon India which possesses such an excellent network of railways, which has a hard-working population, 90 per cent. of the 315,000,000 people being born agriculturists, and *cotton has been an important crop in India since time immemorial. It is true,* crops are dependent largely on the monsoons, but on an average I do not consider the climate of India any more unfavourable than that of the United States; besides Government has brought into being a bountiful system of irrigation, specially in the North, and the Indian ryot has discovered that the irrigation of cotton is profitable; indeed in Madras and the United Provinces the number *of wells constructed recently for this purpose is a very welcome sign.*

The present growth of cotton in the world has been estimated by my Chairman, Sir Charles W. Macara, Bart., to be 21,000,000 bales of 500 lbs. each, but it must be borne in mind that the *consumption is yearly increasing.* The first signs of progressing civilisation are admittedly that the people clothe themselves in cotton garments. As an example of the increasing demand, let me state that according to *Government figures the Indian uses now annually about 12 yards of cotton* cloth (power and hand-loom woven), but with the increased prosperity of the native he is almost certain to spend more money on his family's clothing and we shall be forced to find enormous additional quantities of cotton. Let me illustrate this by stating that if each Indian consumes only one more yard calico per year, we require an additional 175,000 bales of 500 lbs. If you bear in mind *that the weight of cotton cloth produced on power* looms and consumed in India has increased from 536,960,200 lbs. in 1896-97 to 988,027,318 lbs. in 1912-13, it is evident that we must reckon with an enormous increase in the near future in the requirements for the clothing of the Indian population; these figures mean that in 16 years the consumption has increased by 80 per cent. I quote Government figures. But there are other vast countries, such as China, Africa, Central Asia, etc., where civilisation is only just making itself felt. It must also be considered that cotton

has entered into many new uses in Europe, such as motor car tyre covers, aeroplane cloth, bagging, etc., and in consequence of the mercerising process large quantities are now required for imitating silk textures for the very wealthiest classes. The extension of the spinning and weaving machinery to comply with this increased demand has taken place and will continue, but the cotton industry is powerless, if it cannot obtain the raw material.

This *enormous and ever-increasing* demand for raw material secures to the cultivator for many years *to come a remunerative price for his cotton crop.* It is not twenty years ago that Middling American cotton, which rules the price of all other cottons, was 3*d.* per lb., but now the spinners have got accustomed to 6½ and 7*d.* per lb. From these remarks you must conclude that there is no fear of the present high level of cotton prices making way for a lower one for a long time to come. The Indian Government are therefore justified in fostering the growing of cotton wherever it can be done commercially. In almost all the cotton growing Provinces of India, cotton is already the most remunerative crop above all others, and I am inclined to think that it could be made the best paying crop in all such Provinces with the help of an increased staff of Agricultural Experts. It may be of interest to give you a few figures as to the profit resulting to the farmer from the various crops. In the neighbourhood of Aligarh, I discussed this question with several farmers in the presence of the Deputy Director and these farmers stated that they made Rs. 57 per acre nett profit on cotton, on sugarcane they had only Rs. 20-6-0 an acre, on wheat Rs. 22-8-0, on maize about Rs. 20. These figures refer only to the best land round Aligarh, but my investigations in the Punjab show similar results in favour of cotton. Remember also that cotton occupies the land only 7 months, whilst sugarcane prevents the land from being used for another crop for 1½ years and sugarcane requires more water than cotton, which is of importance in irrigated tracts.

The Department of Agriculture has done already some *very good work. Let me assure you* that any one who travels through the country and observes the work of that handful of European Experts employed by the Department of Agriculture must be astounded at the results accomplished. I know a good many of your experts and I have been able to follow their work from year to year. These men are the finest productive investment the Government of India possesses, they are more valuable even than the irrigation canals of the Punjab. They have, to a large extent, been responsible for the increased cotton crop; which will mean an additional income to India this year of £16,000,000.* As a further example of the remunerative investment which the Government has made in the employment of Deputy Directors, I may state that in the United Provinces a variety of cotton has been introduced which yields, on an average, Rs. 15 per acre more than the cotton hitherto cultivated, and of this variety 80,000 acres will be sown next year, which means that an additional Rs. 12,00,000 will come into the hands of the cultivators. Similar cases of increased incomes to the zemindars in Sind and the Punjab have quite recently come to my knowledge. The case of Cambodia cotton in Madras is another example of this productive investment, and incidently the cultivation of Cambodia in Madras has been the cause that many cultivators have invested their savings in the construction of wells, thus rendering vast stretches of land immune from famines. The *spinners* of the world are *recognising these services* and at every deputation to the Secretary of State for India *have strongly urged an increase in the number of Agricultural Experts*, but I am *afraid that the Government of India do not yet fully realise their value. The insignificant sum* which the Government of India spends on this Department was £215,667, for 1911-12, and I am told that a large percentage of this sum was spent on the teaching staff of the Agricultural Colleges which is hardly of immediate profit to the land. This sum of £215,000 does not represent the correct nett expenditure, for—as far as I can learn—the receipts from the sale of farm produce are not deducted from the expenditure. That item must be of considerable importance. The land revenue of India during 1911-12 was £20,000,327 and yet not 1 per cent. was spent for the improvement of conditions of agriculture. An increase on the yield of the land means an increase in the revenues and this seems to be frequently left out of consideration. Compare this figure with that of any other agricultural country. *I believe, I am right in stating that in that comparatively tiny* piece of country, Egypt, with its 5½ million acres of cultivable area, there are as many agricultural experts employed by Government and private firms as in the vast continent of India. On the few little islands of the West Indies covering less than 1,000,000 acres some thirty skilled men with different qualifications such as Chemists, Botanists, etc., are at work, but the United States of America can, no doubt, boast of the most perfect Department of Agriculture with its Secretary Wilson and his staff of 12,000 assistants. The *Federal* Department of Agriculture in the United States of America spent in 1901 $3,303,500 and last year this figure had been increased to $16,000,000 or considerably over 3 million pounds sterling. How does this expenditure compare with the *Imperial* expenditure of the Department of Agriculture? *Add to this the large expenditure* of each State for its farms. Frankly speaking, *the cotton spinners hold the opinion that the Government of India are not spending one-tenth part on the Department of Agriculture of what they* ought to do. The United States of America and other countries recognise that agriculture has become a profitable science and that a large energetic staff is a sound investment. If one considers that 90 per cent. of the people of India live on Agriculture and not 1 per cent. of the Land Revenue is spent annually for the improvement of the conditions which lead to a more profitable system of agriculture, it must be patent to every body that a very large additional grant is long overdue.

I calculated the other day the area under the supervision of one of your Agricultural Experts and found that the Department of Agriculture expects him to look after an area larger than the whole of agricultural Egypt. Whenever my Committee petitioned the Secretary of State for additional men, they were told that the posts in the Department of Agriculture were earmarked for Indians, and that the European was too expensive a material to be employed largely, but the discussions on agricultural education this morning have shown that the Indian Government spends Rs. 11,000 on every graduate from the Lyallpur College. The European's education costs nothing to the Indian Government and the Indian, after certain apprenticeship, receives the same salary as the European. I think, therefore, the Indian expert is the more expensive material. You know *that for the first year's course* of Agriculture at Lyallpur College, no students have offered themselves and at other Colleges the candidates who intend to devote themselves in after-life to agriculture are not numerous. You know better than I the percentage of failure at these Colleges and how much is 'cram' knowledge. It is evident that Indians *in the necessary* numbers cannot be obtained at present for the higher posts and any *further hesitation in the employment of say 10 additional European Agricultural Experts means withholding the produce of the soil for which not only the cotton industry, but also other industries are clamouring.*

I would like to say with regard to the Agricultural Education that the *Vernacular Schools* which I have seen at Mirpurkhas and Lyallpur seem to fulfil the want for the education of the *cultivator* perfectly well.

I will now mention a few points of advantage which I have met with in Egypt and the Soudan, where I have studied the cotton question in detail. I wish it to be distinctly understood that I do not, for one moment, think that all these Egyptian reforms could be grafted on to existing conditions in every Province in India, but I do think, one or the other measure might be found suitable for this or that Province. I am not speaking of idealistic reforms but of accomplished facts which were carried out among cultivators of much the same standard of intelligence as the Indian ryot. In the first instance I would suggest that *Government Farms* should be classified into:—

(a) Research Farms;
(b) Demonstration Farms;
(c) Seed Farms.

* Actual calculation seems to indicate £12,000,000 as the correct figure (Secy. of Board).

I need not explain further the object of this division, but to say that unless you can show the cultivators how much profit you have made out of a certain area, it will take a great deal of persuasion to get him to follow your methods. A Research Farm should be merely devoted to various kinds grown, to different distances in the planting, different applications of manure, etc., and no attempt at a profit should be made, but a demonstration farm should in the first instance show how much money it has made each year in a way which the ordinary cultivator is able to adopt; at the entrance of each farm a board should be put up, showing exactly the expenditure and the receipts, even if only few can read it. I have been repeatedly told on your demonstration farms that you do not aim to make them self-supporting; *to my mind, unless you demonstrate that you have obtained a good profit, the work is only theoretical* and not practical. I may here cite the example of the Egyptian Agricultural Department: all over the cotton growing area they pick out *inferior land of say 4 or 5 acres*; a contract is then drawn up, by the terms of which the Department has the full direction of all the operations of the land and guarantees a crop equal at least to that of the neighbouring fields, and the proprietor has the full benefit of any increased yield. The cultivator on his part agrees to pay for and carry out all the ploughing, sowing and hoeing operations in accordance with the *directions of the officials of the Departments; 44 of such farms were* under the supervision of the Government last year and beyond the wages of Farm Superintendents this excellent method of demonstration has cost Government nothing. From what I have seen on your farms you have Indian people qualified to carry out such work, but probably more are wanted. The result in Egypt has been, that in some cases the yield has been doubled, but in all cases has there been a substantial increase against the crops in former years. The moral influence of such farms cannot be over-estimated.

Of the Seed Farms on the model of those of the Central Provinces I have spoken at length in my report on my last visit and I am pleased to see that in several Provinces your Department is taking steps to follow this recommendation. I am also glad to hear that Mr. Conville of Lyallpur has been so much impressed with the necessity of additional seed-farms on this plan, that he has applied, and has been granted, an area of 3,000 acres in Lower Bari Doab Colony of the Punjab for this specific purpose.

Nucleus Seed Farms from which the variety is constantly kept up in its most perfect form *should be owned by Government and should be used for recruiting purposes.* The seed from the Seed Farms can in many districts be distributed by the Co-operative Societies or Agricultural Associations, but where these do not exist, or are not as perfect as you would like them to be, I would suggest that *the Department of Agriculture should undertake the distribution of cotton seed.* I again hold up as example the Department of Agriculture of Egypt. Mr. Gerald C. Dudgeon, the Director General, introduced there the system that the Department sends to small cultivators, of whom there are over one million in Egypt, best selected seed charging them with the cost price and recovering the amount due for the seed, without interest, six months later. These amounts are collected by the Government Tax Collectors. The seed is obtained from some of the Government Seed Farms, but mainly from reliable ginneries; and in distributing the seed over the country, the Department takes care that only one variety is sent to a village, not several, as this would lead to hybridising. Such a system I strongly advocate for the new Canal Colonies, especially the Lower Bari Doab Canal Colony where you have not yet Agricultural Associations, nor Co-operative Credit Societies. That land will be suitable to produce the American kind of cotton, of which this season, I am immensely pleased to say, Lyallpur District has grown some 25,000 bales. The Department *could easily obtain the seed by purchase at the ginning factories; a child can distinguish the Lyallpur American seed from the* "Desi" seed and more than enough for the whole of the Punjab could be obtained in Lyallpur. I understand the principal reason why a stipulation requiring tenants in the new Canal Colonies of the Punjab to grow a small proportion of their area with American cotton was not agreed upon, was the fear that the Department would not be able to find the seed. I think any of the officers will confirm the statement that sufficient American seed *is* obtainable. Where the system of seed distribution by the Department is not feasible, it might be worth considering what steps could be taken to encourage the now dying out practice of hand-ginning the seed intended for sowing purposes; for instance prizes at shows might consist of *churkies.*

No *experimental* or *seed farm* should be considered complete without an *adequate ginnery* driven by power. You know the dirty condition in which the ginneries as a rule are, and no matter how careful the Government officials are when superintending the ginning in a hired factory, some mixture is almost sure to occur; besides these factories are too busy in the season to attend to small lots and your officials have other more pressing duties than to spend time watching at the ginneries.

With few exceptions the *ginning factories* of India are badly managed and most of you will admit that they are to a very great extent responsible for the degeneration of Indian cottons, consequent upon the mixing of the different lots of seed. It seems to me hopeless to obtain real progress in the *improvement of staple and yield*, unless some reforms are introduced in the *ginning factories.* The work of the Agricultural Department is frequently undone by the ginning factories. I grant, it is a difficult question, but what was possible in the Anglo-Egyptian Soudan should not be impossible in some Provinces of India. By issuing special licences to ginning factories, making the whole business of cotton ginning a *licensed* one, I venture to think a great improvement could be effected. The ginning licences of the Anglo-Egyptian Soudan state that they are for one year and renewable, unless breaches in respect of any of the provisions of the cotton ordinance have been committed. The main provisions mentioned are:—

(1) Different varieties of cotton shall be kept separate previous to ginning and shall be ginned separately.

(2) *The gins shall be carefully cleaned of all seeds of one variety before the ginning of another* variety is begun.

(3) Every ginning factory shall at all times, while working, be opened to the inspection of an official, duly authorised by the Director of Agriculture. The regulations also prescribe the furnishing of statistical data and make the adulteration (which includes damping) a punishable offence.

Now as regards *damping* of cotton:—There are two methods of damping, the one is carried out by the farmer and the other by the ginner or owner of presses. It is the latter damping of cotton which causes the greater loss and injury to the cotton spinner and I will therefore deal with it first.

The photographs taken two years ago at Akola which I published in my last report have, I may claim, made history. On the Continent of Europe and even in America these photographs are hung up in the buying offices of the cotton mills and are looked upon, I am obliged to say, as a disgrace to *India. The President of the New York Cotton Exchange spoke as follows at the Scheveningen Congress* of 1913:—

"In the United States there is no watering of cotton during the process of ginning and baling such as has been *described by Mr. S. M. Johnson and Mr. Schmidt (referring to the* Akola picture). I am prouder than words can convey of the honesty and integrity of the American cotton planter, for if the planter, or middleman, or the ginner of the United States were to resort to the methods which are adopted in India, *the law would put him into a penitentiary.*"

As mentioned before what the spinners most object to is the watering *after* ginning, *i.e.*, prior to pressing. Some owners of presses allege that it is necessary to water the cotton, in order to obtain the requisite pressure. I have spoken with managers of presses in such hot and dry places as Sind and the United Provinces who have said, no matter how dry the air is, the bales *can* be pressed without watering the cotton, although when the cotton is watered the process of pressing may be easier.

There is absolutely no need to water the cotton. The effect of such watered cotton is as follows:—

In the course of railway transit and whilst the bales are exposed to the broiling sun on the Cotton Green in Bombay the moisture from the outside portion of the bales will evaporate, but inside in the centre, a kind of fermentation takes place and by the time the bale arrives in Europe the core of the bale has become rotten and useless; in opening the bale a fusty stench emanates and it is only then that the fraud is detected. The *Government says to us: "The remedy lies in the hands of the trade itself."* How can the spinners trace the presser of a bale, say 6 or 9 months after the bale has been pressed, for in that time the bale has been in the possession of many parties. Cotton, you must remember, is bought and sold in open market, and it is difficult, if not impossible, for the ultimate purchaser to trace the person or firm who watered the cotton, and almost equally difficult to discover the firm that exported the cotton from India. As several Government officials do not seem to have understood the remarks made by spinners on the occasion of the Deputations to the Secretary of State for India, I will illustrate a case that has recently occurred to a cotton mill in India; it is a typical case. A lot of 499 bales of Dharwar cotton was purchased from a European firm of the highest standing in Bombay. The bales were invoiced as weighing 187,087 lbs., on arrival at the Mill they weighed only 186,095 lbs., *i.e.*, an actual loss of 992 lbs. or Rs. 360 had to be borne by the cotton mill. On representation being made, the Bombay cotton sellers wrote: "We consider this shortage was to be expected." It is true the climate in Bombay is more moist than the place where cotton mill is situated, but certainly this difference cannot be 2 lbs. a bale. It is undoubtedly a case where the cotton had been watered prior to pressing and had lost in transit some of the water that had been artificially put in; in fact the cotton is still moist and will lose more weight yet. Twenty days after arrival of this cotton in the mill I had 50 lbs. put into the open air on a day when *the sky was clouded and rain threatened, yet the cotton lost in one hour 1 per cent., i.e.*, after the first loss of 2 lbs. a bale. This means that instead of having bought the cotton at the rate agreed upon, the firm has had to pay a higher price than it had calculated. We are told by Government to discontinue buying from a firm, if in a case like this no redress can be obtained, but the experience of spinners has shown them that such cases are of frequent occurrence everywhere and the various resolutions from the Indian Chambers of Commerce point to the fact that the practice is on the increase and in some districts is universal. Every cotton firm has almost weekly claims of this description. *All that the spinners desire is that there should be an Ordinance making the watering of cotton after the process of ginning in any ginning factory or in any place set apart for that purpose, criminal. Then any aggrieved party, whether a spinner or a cotton broker, can proceed against the offender according to law.*

This question has now been laboured for many years and the delay in applying a remedy which spinners in England, on the Continent of Europe and in India consider of urgent necessity, is bound to be interpreted by some as sanctioning a fraudulent practice, and this must lead to its spread. I lay special stress on the fact that the spinners do *not* want for the remedying of this practice a Bombay Cotton Fraud Act; they do not wish the Government to engage a single additional employé for the purpose; all that is wanted is an Ordinance that will enable the spinners or others to proceed against offenders. Surely that is not a prohibitive request.

The practice of *damping cotton kapas*, as distinct from that of damping the lint, *must be considered a separate problem.* I am told by buyers of *kapas* in India that they have no difficulty in putting a man into jail who hides inside his bag or load, of *kapas* a stone for the purpose of fraudulently increasing the weight. I would like to know what is the difference, whether a man uses water or a stone for adding weight? It is often maintained that the adding of water cannot be proved, but that is a wrong assumption, as several of your officers have seen deliberate watering of cotton; besides there is now an apparatus in existence which will indicate the moisture in cotton to a very fine degree. It has been pointed out to me by such large buyers of Punjab cotton as Messrs. Ralli, Volkart and Gaddum (see Karachi Chamber of Commerce Resolution) that the practices of watering and otherwise adulterating cotton in many markets of the Punjab are on the increase. Your officers know that Khanna specially is the place, where this practice is in vogue. I am told that at Hansi the cotton warehouses are *regularly damped. Sarghoda cotton is also not free from water; in short,* if your officials will get into touch with any of the large buyers, information to satisfy them will be readily obtained. The Director of Agriculture of the Punjab issued recently a circular drawing attention to this practice; it reads:—" During the last two years attention has been directed to the prevalence in India of a practice of damping cotton in either *rui* or *kapas*. Damping is practised in order to increase the weight of cotton, and this is a fraud." Mr. Hamilton then goes on to show that the quality of the cotton is reduced through damping, etc. In short the circular is excellent, only it does not say that the practice is a *punishable* offence.

As regards the North-West Frontier Province I am assured by a Government official in Peshawar that there is not a bale of *kapas* brought to the ginning factory that is not damped. You are no doubt aware that almost all the *kapas* in the North-West Frontier is transported in net or string bags, and, partly in order to get as much cotton in one load as possible, the cultivators *damp the cotton*, as it will then go into a smaller compass. I have also been told that these bales are at times rolled through the mountain streams on the way to the ginnery. I examined several bales on the road and did not find a single dry one.

In Sind I have convinced myself that no watering i done; on the contrary, all the *kapas* is spread out in the sun on a specially cemented platform. That practice does not exist in the Punjab and the North-West Frontier, but it is strongly to be recommended.

As regards the *mixing* of various cottons we have complained repeatedly and recently my attention was drawn by large cotton buyers to the mixing that is going on between North-West Frontier cotton and Punjab cotton. A definite case has come under my notice and I will give names of places to any one interested. In this case unginned cotton is brought from the North-West Frontier to a ginning factory in the Punjab. Why does this ginner go to the additional expense of the carriage on the cotton seed, when he could have the *kapas* ginned in the North-West Frontier Province? That cotton is used for deceiving the *buyer of Punjab Desi cotton.* It will not only deceive the buyer, but it will also cause degeneration of the cotton when the mixed seed is sown in the following year, and I think, on the strength of this injurious effect, your Department ought to take action. Lord Kitchener, who, by the by, is very keenly interested in everything pertaining to the cotton-growing industry, stopped effectually a similar case of fraudulent mixing between Lower and Upper Egypt by defining a boundary over which no *kapas* could be sent.

I have talked during the last month to a great many farmers and ginners and have explained to them that the shortest fibre in one lot indicates the price of the whole lot; it is with cotton exactly

as with a chain, the strength depends solely on the weakest link. The inborn gambling element of the natives seems to prompt him to continue this and other fraudulent practices, even when he has suffered a financial loss through them on various occasions. The Lyallpur cultivators and Government officials are astonished that not much of a premium is paid over Desi cotton for the Lyallpur American cotton. The enigma is easily solved; the ginner who is also the buyer mixes in almost every case American and Desi cotton, you can see plainly to what extent it is done by watching the seeds fall into the sacks below the gins. The American seed being green and the Desi grey, the percentage is easily recognised; and in pulling the staple, it is also evident at first glance the fibres differing in length the same as the pipes of an organ. Of course under such conditions the spinners cannot pay a premium over the ordinary cotton. I visited several fields and convinced myself that the fault does not rest with the cultivator. Now unless the Department takes up the sole supply of the seed or stops the ginner from mixing the *kapas* your labours in that Province will be in vain: I believe that a licence as described above would be an effective remedy.

From what I have so far seen the Agricultural Departments of the Provinces which I have visited stand in urgent need of additional assistance, for the purpose of carrying on work in localities which, owing to the enormous area, have so far not been touched. *Experimental Farms* in those districts are a primary necessity and for both these objects funds are required.

Hardly any extensive work is undertaken by the cultivators in India to stop the *ravages of the boll-worm*. In Egypt at the commencement of a season a whole army of officials is sent out to every village who see that each cultivator has the worms in his field carefully picked. If a cultivator fails to do this, he is fined and the penalty consists in his having to pick the worms from his neighbour's field; and by the 31st December all cotton stalks and roots must be removed from the fields, as otherwise they provide food in spring.

In some parts of India you have *cotton-markets*; this system of markets has been copied by Lord Kitchener in the Soudan, but it has been improved upon. Government engages for each market a grader, a man who classifies all the cotton upon arrival into four classes. Special attention is paid in this work to uniformity of staple, colour, strength and cleanliness. All the cotton, after it has been duly graded, is sold by auction. When a cultivator sees that his neighbour's cotton has been branded A class, whilst his own is only B, he naturally copies his neighbour in his future field work. Such a system would not be feasible where the cotton comes into a market in very large quantities or varieties, but I think in a place like Peshawar it would be a great help. On the one side of Peshawar beautiful cotton is grown on stream irrigated land whilst on the canal irrigated land the cotton is poor. In this case, too, the two kinds, as different as cheese and chalk, are mixed together in the ginnery, luckily the farmers hand-gin the cotton, the seed of which they require for sowing. Although the Peshawar cotton crop is small (at present 13,000 bales) yet I think there is scope for the work of a Botanist as the ginning outturn of the cotton is only 25 per cent. Perhaps the Botanist from the Punjab or United Provinces might be lent to the North-West Frontier Province for short periods.

I am pleased to see from the reports of the *Co-operative Credit Societies* that they are extending and that the *Agricultural Associations* are making good progress. I read the other day of a suggestion in the paper that the right way to grow cotton might be taught to soldiers, as they would acquire in this way a knowledge that would come in useful in their after-life. Agricultural instruction is given in some of the Continental armies. The ordinary village schools can also help. In Egypt all school children have to learn by heart an address delivered by Lord Kitchener on the best way to grow cotton and to fight the cotton insect pests. It is entitled "Reconnaissance before the Battle."

Another means of lightening the burden of the cultivator would be the *prohibition of the secret commission* in connection with the Takavi fund. In Hyderabad (Sind) I was told by a cultivator that he would have to pay 2 annas per rupee besides the 6 per cent. interest: in another place in Sind, a Treasury Official said the commission was only 1 anna per rupee, *i.e.*, as much secret commission as interest. The official said, the cultivators do not mind paying this because the clerk under such circumstances is lenient in fixing the assessment.

At one time we were told that the extension of *cotton* would interfere with the growing of *food supplies* but as according to Government statistics the percentage of the gross cropped area of India was:—

79·17 per cent. under food crops in 1901-02.
4·5 per cent. only under cotton in 1901-02.
79·66 per cent. under food crops in 1911-12.
5·9 per cent. cotton crop in 1911-12.

I think that fear has now vanished; besides cotton requires a food crop for a rotation. Although the ryot may not be able to eat his cotton, as one high official kept telling me on my journey, yet it pays him well and with the help of the splendid railways he can purchase his food from other localities, and even in famine years India exports food crops. I grant, the man who owns only an acre must, in the first instance, devote it to food crops. The cotton seed cakes, or better the meal of the cakes, forms in all agricultural countries an excellent cattle food, which is not yet sufficiently used in India, as was pointed out at this Conference by Mr. Smart. It can be packed in a small volume and can easily be transported by rail to famine districts. These seed cakes have found great favour in England and the United States and one may justly look upon cotton more as a fodder than a fibre-producing plant as the seed grains are the heaviest part of the crop. The cotton seed oil is largely used for food by the Indians.

In conclusion, I have every confidence that, with largely increased expenditure by the Department of Agriculture, India will not only be able *to supply the cotton industry of the world with as much cotton* as United States are growing now, but I am also sure, in view of recent developments, that cotton of a quality will be grown in India which will compete with that grown in America. The progress already achieved has been wonderful and the Indian Department of Agriculture deserves the highest encomium.

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